HIGHER SCHOOL CERTIFICATE CHEMISTRY IN TASMANIA

THE LAST TWO DECADES

A study of the changing pattern of HSC Chemistry in Tasmania in the period 1966 - 1988.

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ABSTRACT

Chemistry at the Higher School Certificate level has changed dramatically in the last twenty years.

This thesis is concerned with those changes, the reasons for the changes and the way they have been brought about.

The changing pattern of student intake is studied first on a world-wide basis and then from the particular view of the Tasmanian scene. Then follows an account of the many and varied changes to the curriculum, examinations, and assessment techniques. The effect of these changes on student numbers is also correlated.

The period 1966 - 1988 has seen a progressive change from a stereo-typed traditional chemistry course to the more conceptual CHEM Study Course and finally a truly Australian developed course. These changes are studied in depth.

During the same period the student population has changed tremendously. In the 1960's students were faced with a massive load of rote-learning and a practical experience that was very limited in scope. Today's students are allowed to

take the text book into the examination and carry out many diverse experiments in the laboratory. These facets are considered and from questionnaire material the reactions of both students and teachers are given.

Changes from a complete external assessment to the present half external and half internal have taken place progressively over this period. This has affected the teaching methods particularly regarding methods of assessment.

The changing nature of the student population in the Years Eleven and Twelve has caused much thought and debate. Changes to Chemistry curricula have attempted to cope for the varying student intake. These changes are documented and discussed.

The roles of both the University of Tasmania and the Schools Board of Tasmania have played a very important part over the period and help from both parties has been readily forthcoming and is well documented.

In conclusion the thesis, is in effect the "Tasmanian Chemistry Story". The major changes which have taken place over the last two decades are mainly unknown to a large percentage of the teaching staff in Tasmania and so it is

believed that a document of this type may serve as both a reminder of the past and guide to the future.

STATEMENT OF ORIGINALITY

This thesis contains no material which has been submitted for examination in any other course or accepted for the award of any degree or diploma in any university, and, to the best of my knowledge and belief, contains no material previously published or written by another person except where due reference is made in the text.

Signed .....

Date .....

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Finally my wife Sheila and my family who have coped with my many traumas and tantrums.

I THANK YOU ALL MOST SINCERELY

CHAPTER ONE

THE SWING AWAY FROM CHEMISTRY

1.0 Introduction

Since the early nineteen fifties, teachers and educators have been deploring the fact that the number of students studying Chemistry, particularly at the 15+ level, has been steadily declining. Numerous reasons have been given, even more solutions to the problem attempted, but still in the nineteen eighties, the numbers appear to be dropping. This section will attempt to collate findings from overseas and the mainland and compare them with the Tasmanian situation.

1.1 Retention Rates in Chemistry - Findings from the United Kingdom

At the Association for Science Education Conference, held in Nottingham UK in 1968, Newall[1] found in a summary of reports by members throughout the country that a significant proportion denied the existence of a swing from sciences whilst other members suggested that there was not so much a swing away from science as a shift of emphasis from physical sciences to biological sciences.

This was contradicted by the highly regarded Dainton report, commissioned by the Council for Scientific Policy, and published in 1968[2]. In their interim report the committee drew attention to the buoyant growth of science and mathematics in the schools up to General Certificate of Education "Ordinary" level, and to increased numbers of school leavers specialising in science. Later results showed this qualified optimism was not sustained and found that science and mathematics were losing ground relatively in the sixth form and that since 1960 the proportion of school leavers specialising in them had declined in relation to other subjects of study and specialisation. Between 1962 and 1965 the Council discovered 4 000 science places were vacant in

universities and that it was likely that the number of sixth-formers studying science would fall from 40 000 in 1964 to 31 500 in 1971. At the same time those not studying science would rise from 54 500 to 76 000. The situation in Scotland was much healthier because its secondary courses were more broadly based, new syllabuses in mathematics and science were more quickly adopted, and Scottish students were helped by the four-year courses at university and by the opportunity given to students to change their minds about their major interests.

A similar swing from science and technology had been detected in Australia, Germany and the Netherlands, but it had not occurred in the USA (at that time) or France. In the latter country nearly 75% of all pupils in the first year of baccalaureat followed courses with a science bias. The comparable figure in the UK was 42%. Remedies suggested to combat this drift included the recommendations that:

i) sixth form courses should be broadened

ii) choices should be left as late as possible

iii) all pupils should study mathematics throughout the whole of their school lives

iv) science teaching should be made more attractive

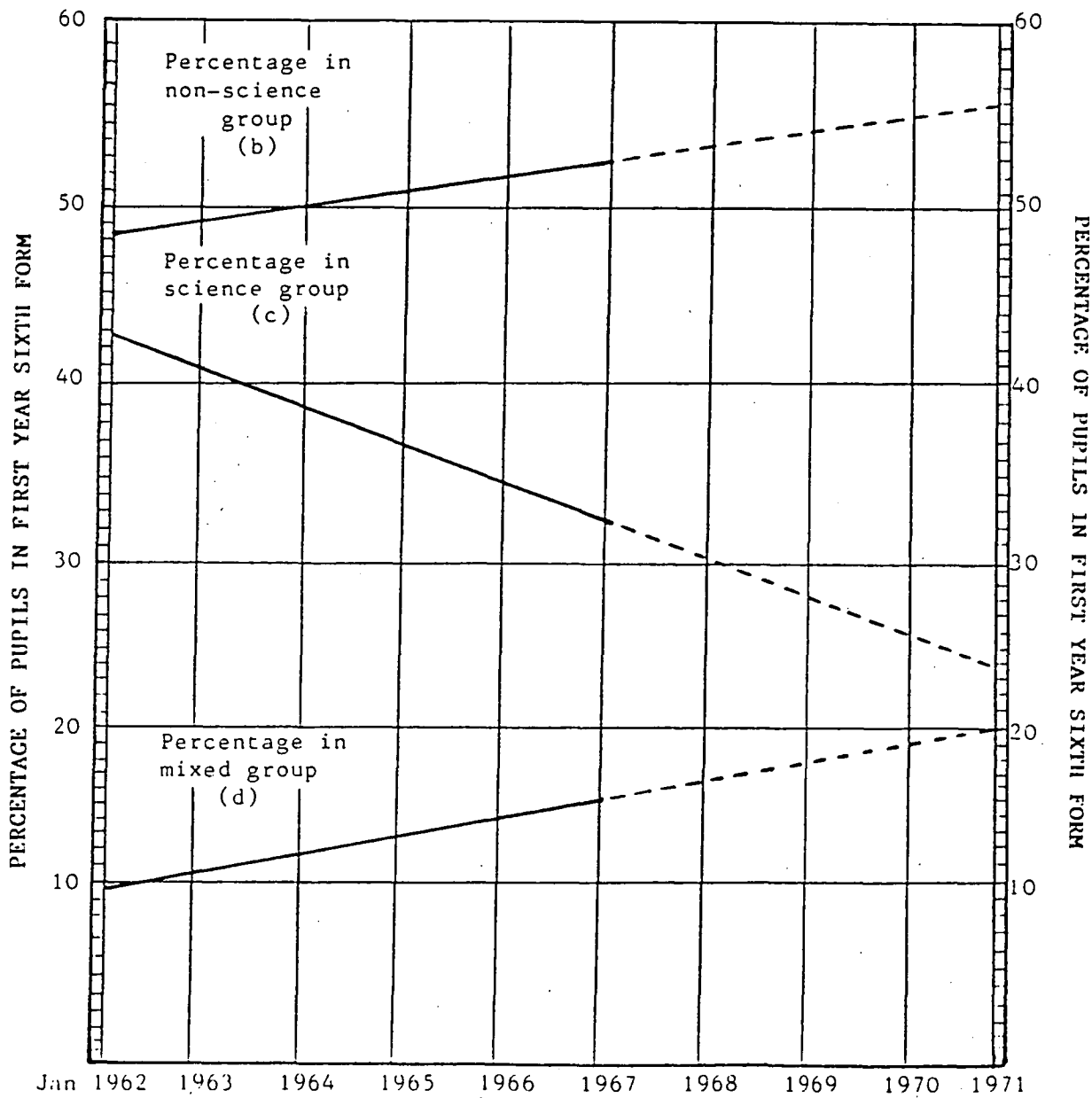
v) there should be a system of incentives in these fields more attractive to the young.

In 1986 these remedies are still being discussed but very few have been implemented.

The swing away from the sciences in the period 1962-1971 is shown dramaticlly in Figure 1 reproduced from the Dainton report.

FIGURE 1

PROPORTION OF FIRST YEAR SIXTH ON EACH TYPE OF 'A' LEVEL COURSE



Eight years later Prestt[3] reported that during recent years (1968-76), there had been a massive expenditure on curriculum development in science, but there was little evidence that this had produced the hoped-for re-emergence of interest. Statistics for A-level pass rates showed that although there had been a considerable increase in the total number of passes in all subjects the relative proportion of passes in the physical sciences had fallen[4]. As a consequence the number of students entering physical sciences at university and polytechnic levels was lamentably low and had led to a drastic drop in the number of science graduates applying for teacher training. Obviously the forebodings expressed in the Dainton report were coming true.

Tall[5] in 1979 analysed the examination entries of GCE and CSE and concluded that there had been a relative increase in the numbers of entries and a considerable change in the overall pattern but the very slow increase in the uptake of Physics and Chemistry was "disastrous".

Figures from Scotland[6] for 1978 showed that 62% of girls and 34% of boys did not pursue science into the final year of schooling. This was in an area of the country reported to be "much more healthier" by Dainton.

1.2 Retention Rates in Chemistry - The position in the United States

In the US, major interest in the revision of science courses was sparked by the Russian launching of Sputnik in 1957. America suddenly appeared to be behind in the technology race and millions of dollars were expended to improve the position. A proliferation of new science courses was expected to lead to a corresponding increase in the number of students taking these courses. Whilst many of the courses were imaginative in design, the hoped-for increase in numbers did not materialise.

Rowe[7] in 1983 reported that students call certain courses "killer" courses and General Chemistry carries this label. Failures, drop-outs, and repeat rates for non-majors in general Chemistry equals, or exceeds 30% in many institutions in the USA.

Hermann[8] studied American Scholastic Aptitude Tests scores from 1963-1981 and found that young American students were becoming worse at science and mathematics. This had led to

less qualified teachers in the schools and in many cases science classes were being taught by non-science graduates. This is turn leads to lower numbers of students retaining interest in the physical sciences at Grades 11 and 12 and compounds the problem - indeed a vicious circle which is difficult to break. In the research and development field, the USA has been forced into the position of hiring immigrants to fill vacancies at this level. The National Science Foundation[9] studied world-wide figures for the per cent increase in numbers of scientists engaged in research and development for the period 1965-1979. These figures are shown below:

Soviet Union	140%
Japan	139%
West Germany	100%
United Kingdom	76%
France	75%
USA	25%

Unfortunately, comparable figures are not available for Australia but during this period many science teachers were being recruited from other countries to fill the positions vacant and figures would probably parallel those of the

United States most closely.

In a prize-giving speech at the Californian Institute of Technology in 1981 the President of that institute attributed this in part to the High Schools. He stated:[9]

> "I want to emphasise that in the current debate over science and technology, that all aspects of high school education are lousy. Not just the education in science and mathematics. The whole thing is rotten."

Some part!

In the same report[9] Ramo states:

> "there needs to be a federal education crash programme that requires money and organisation - we've got a disaster pending if we don't change."

Spencer (1984)[10] believes there is a general tendency to focus blame for scientific illiteracy and decreased interest by students on the high school. He apportions some of that blame to the close ties of secondary education and the university system, which are usually ignored. Secondary

teachers are direct products of a higher education system that often attributes the failings of high schools to inadequate teaching. Education systems are essentially reactive, responding to societal pressures. Because of lower qualifications institutions of higher learning are forced to relax their entrance requirements, secondary schools respond and educational quality declines. It is possible to reverse the trend. Graduate schools depend on a supply of undergraduates and thus have a vested interest in helping strengthen the undergraduate sciences. As will be expounded later, this trend is already apparent in Tasmania. Few students who have not been motivated by early educational experiences for a career in science will opt to enter the sciences at later levels.

Walford writing in the Journal of Chemical Education in 1983[11] lists three critical periods in the history of science teaching in the United States.

i) 1869 when the President of Harvard University made High School Science one of the admission requirements. This produced a revolutionary swing towards the use of laboratory instruction in schools, and replaced what had

previously been lecture courses with the occasional demonstration.

ii) 1957 when the Soviet Union placed the first satellite in orbit. The feeling of inferiority generated in America led to a public attack on the science curricula in High Schools. Vast expenditure and effort saw the introduction of several imaginative new courses. In Chemistry the two most successful were the Chemical Bond Approach and the Chem Study Approach. Though differing greatly in rationale they were both intended to generate students' interest in Chemistry. The former, as the name suggests, relates chemical reactions to the bonding in the molecules and involves a study of bonding to a depth often above that of the average student. The Chem Study programme, although based on several theoretical concepts, was more practical in nature, and by 1970 about 30% of US High Schools were using this programme. As will be explained in a later section, it was in 1969 that the Chem Study course was first trialled

in Tasmania.

When Atkinson retired as Director of the National Science Foundation in 1980 he said:

> "I sometimes think that the High Schools have made the science courses so difficult that they have reduced the population of students who take these courses. I'd much prefer to see them taught at a less demanding level, but ensuring that a much larger proportion of students will take them."

Aldridge, the director of the National Science Teachers Association, echoes similar thoughts:

> "The curriculum reforms of the 1960's were purist and elitist. They were intended to educate the top students but they were far too difficult for the majority of students. The result was that science became less interesting to most students and their ability to succeed was lowered."

iii) The 1980's were the third critical period in Science Education - Walford[11] reports the

characteristics of the present crisis are low enrolments in science; a shortage of competent teachers and an increasing public ignorance on subjects related to science and technology. Figures produced in his report show that for every 100 students who complete high school only 16 have completed a full chemistry course. A survey of college bound seniors in 1983 presented an even gloomier picture when only 2.2% of students were opting for the physical sciences.

In 1984 Sousa[12] suggested that pre-college science education in the United States is in serious trouble. In New Jersey he recorded the following figures:

a) Percentage of students enrolled in all science courses rose from 61.9% (1975) to 67.0% (1982) but

b) Percentage of schools using the Chem Study course dropped from 43.4% (1978) to 25.2% (1982). No other alternative Chemistry course was offered.

Sousa concludes that if present trends continue it is reasonable to doubt whether the nation can successfully meet the science needs of its students and society in the coming years.

Further reports spread the alarm even further. Heyton (1982)[13] showed that high school students were turning away from science and thus scores on science achievement tests have been steadily declining over the last decade. Bromley[14], 1982, points to reduced budgets which have led to cuts in time spent in laboratory experiences by science students. Science teachers, particularly in the physical sciences, are leaving the classroom in alarming numbers and this further exacerbates the problem. All in all a very gloomy picture emerges from the USA.

1.3 The Picture in Other Countries

At the time of the Dainton Report (1968) comparisons showed that England and Wales were exceptional in Western Europe in not taking science and mathematics for a significant proportion of those in schools above the age of 15. French

students particularly showed a strong bias towards science at that time; but the picture changes dramatically at the University entrance level. Nearly three-quarters (73%) of all pupils in French schools in the first year of baccalaureat in 1963-64 were following courses with a science bias compared with 42% in England and Wales, but the proportion of university entrants taking science and technology was highest in Great Britain at 45% in 1962-63 compared with 35% in the Netherlands, 32% in France and 26% in West Germany.

Independent evidence from Australia[15] shows that since about 1961 there has been a relative trend away from science and technology by undergraduates in Australian universities.

It must be pointed out that the Dainton report also showed that the study of science and mathematics had gained ground in the United States during the 1960's. This is definitely no longer true in that country as is shown in the earlier section (1.2). More recent work by Gardner[16] in 1984 paints a much truer picture. He surveyed reports from twenty countries on student interest in the fields of science and technology and lists four generalisations:

i) the changes in interest in science displayed by students as they grew older;

ii) the relationship with interest in science of personal variables such as gender and ability;

iii) subject-matter variables which are associated with interest and;

iv) the effect of teachers upon interest.

Taking each in turn, it is unquestionable that students lose interest in science over time. For many students, in many countries, science is a subject which is initially liked but which comes to be disliked and discontinued. Chemistry (and Physics) display sharper declines than other school subjects.

Secondly, males are more interested in physical science at the lower levels and are therefore more likely to enrol in them at the higher levels. Females tend to be more interested in Biology. Personal variables such as attitude and generalisations do not appear strongly related and so it is not possible to conclude that the most able students are invariably the interested ones.

In regard to subject matter, many students report on the difficulty of science, particularly Chemistry and Physics. Students have stated they do not wish to continue with physical science because it is too mathematical, too abstract, too difficult.

Teachers, have a major effect on student choices and the benefits of active student involvement and experimentation, and the use of visual aids are well documented whereas teacher dominated techniques tend to 'inhibit' interest.

The overall results show there has been a general decline in interest in science, particularly Chemistry and Physics but a few gains have been made. In many countries the human and physical resources made available to science have improved.

In some countries, Japan and Israel are good examples, science is widely accepted as vital for national economic progress or security. Schools there have a high retention rate and science subjects are taken at upper secondary level by a large proportions of the age group.

1.4 The Mainland Scene

Mainland Australia, as well as Tasmania, faces similar problems to those mentioned earlier. The Australian Institute of Physics, the Australian Mathematical Society, and the Royal Australian Chemical Institute combined to hold a one day seminar, *A Crisis in Science Education - the interface between Secondary and Tertiary Education in the Physical Sciences* at Latrobe (Vic) in 1984. A report on the meeting[17] said that the emphasis should be towards a greater participation of all students in secondary education, particularly science, with the adaptation of schools to local needs and less emphasis on specialist preparation for tertiary education. Representatives from several education departments placed the responsibility for the crisis on the tertiary side of the interface, pointing out that changes had occurred in the pre-tertiary area and that the tertiary section had failed to respond to them. Notably, tertiary bodies should not expect to dictate school curricula, nor lay down rules for entry and should be more flexible in their selection of students. This caused problems for the secondary teacher in making science attractive and relevant to the overall student population and yet meeting the more specific goals for entrance to the tertiary sector. Speakers

highlighted the lack of interest of girls in taking science and the poor representation of women in science. They drew attention to the dramatic increase in Year 12 population, yet the numbers of students taking science remained relatively constant.

This was countered by speakers from the tertiary area who emphasized the poor preparation of science teachers and the lack of appropriately qualified science teachers. Others advocated a more elitist approach, deploring the lack of rigour in the secondary preparation of students for tertiary studies. Alarming statistics were presented in a review of the educational scene in the United States - would this be the future in Australia? All in all, the only agreement reached seems to be that there is a crisis and that adopting hardline policies on either side of the interface, in the long run, can only be to the detriment of both secondary and teritary education, with the students suffering the most.

An article by Brearley in the Australian in 1986[18] points out that NSW Government schools face an increasing shortage of science teachers, with more vacancies for these positions than for any other speciality teaching area. The Newcastle College of Advanced Education, once a leading supplier of

science teachers in NSW is having trouble attracting enough applicants to run the Bachelor of Education course for science. This meant there would be no graduating class of science teachers from NCAE in 1989. The College has since used special programs to attract applicants, some of whom are university graduates with science degrees who are given six months full-time teacher training and a year in-service, in place of the usual Bachelor of Education Course.

Bassett[19] supports the Alan Bond private university scheme and says a privately funded university could well develop some strengths which are at present rare among Australian tertiary education institutions. There is a lack of general scientific and technical consulting firms in Australia and the new university might set out to fill this niche. There may be scope for part-time sandwich courses in science and engineering and this could be expected to add to the supply of competent graduates. This alone would be an important public service. According to recent OECD data per capita averages Australia needs <u>about five times more</u> people in training for the sciences and engineering, than there are at present.

Mulroney[20] also writes on the drift of students away from

chemistry at the tertiary level; still apparent in 1987. Whereas many people blame the increasing theoretical approach to the subject, Mulroney suggests it is due to the chronic shortage of specialists teaching attractive general science courses in the early years of secondary school. This means young students are discouraged from continuing with these subjects.

1.5 The Tasmanian Situation

That then is the broad picture. What of Tasmania itself? Many of the problems, causes and possible solutions mentioned in the previous section have been discussed in Tasmanian staffrooms and aired at many conferences. Figures for Tasmanian student numbers (p23) were kindly supplied by the Schools Board and Dr P Smith, Chemistry Department, University of Tasmania. They show the changing enrolment, particularly in HSC Chemistry subjects since 1969. It is acknowledged that such figures are useful for tracing historical trends but at the best are only a crude indication. Factors affecting the figures include such variables as population growth (or decline); changes in school retention rates; policy decisions on admission to

tertiary institutions; changes in curriculum; introduction of new subjects and so on. If, for example, HSC Chemistry is a requirement, or an advantage, for entry to certain faculties of tertiary institutions, then chemistry enrolments will obviously be affected. Discussion of these variables will be made, when applicable, in later sections.

The figures in Table 1 and Figure 2 show there was a steady decline in percentage of total students taking a chemistry course at HSC level from 1969-1976. In the period 1977-1983 the fall in percentage of the age cohort taking chemistry was somewhat arrested. but further falls occur in 1984 and 1985.

Over the period 1969-1976, students were required to study the subject for two years in order to gain a full Level III pass in chemistry. The introduction of the separate subjects Chemistry A and Chemistry B in 1977 seems to have arrested the steady fall and since 1978 percentages of the total population taking chemistry, at one of the three levels A, B or II has remained reasonably constant. The increase in Level II candidates is interesting and will be fully discussed in a later Chapter, as will other factors.

Over that last eight years or so there has been a quite

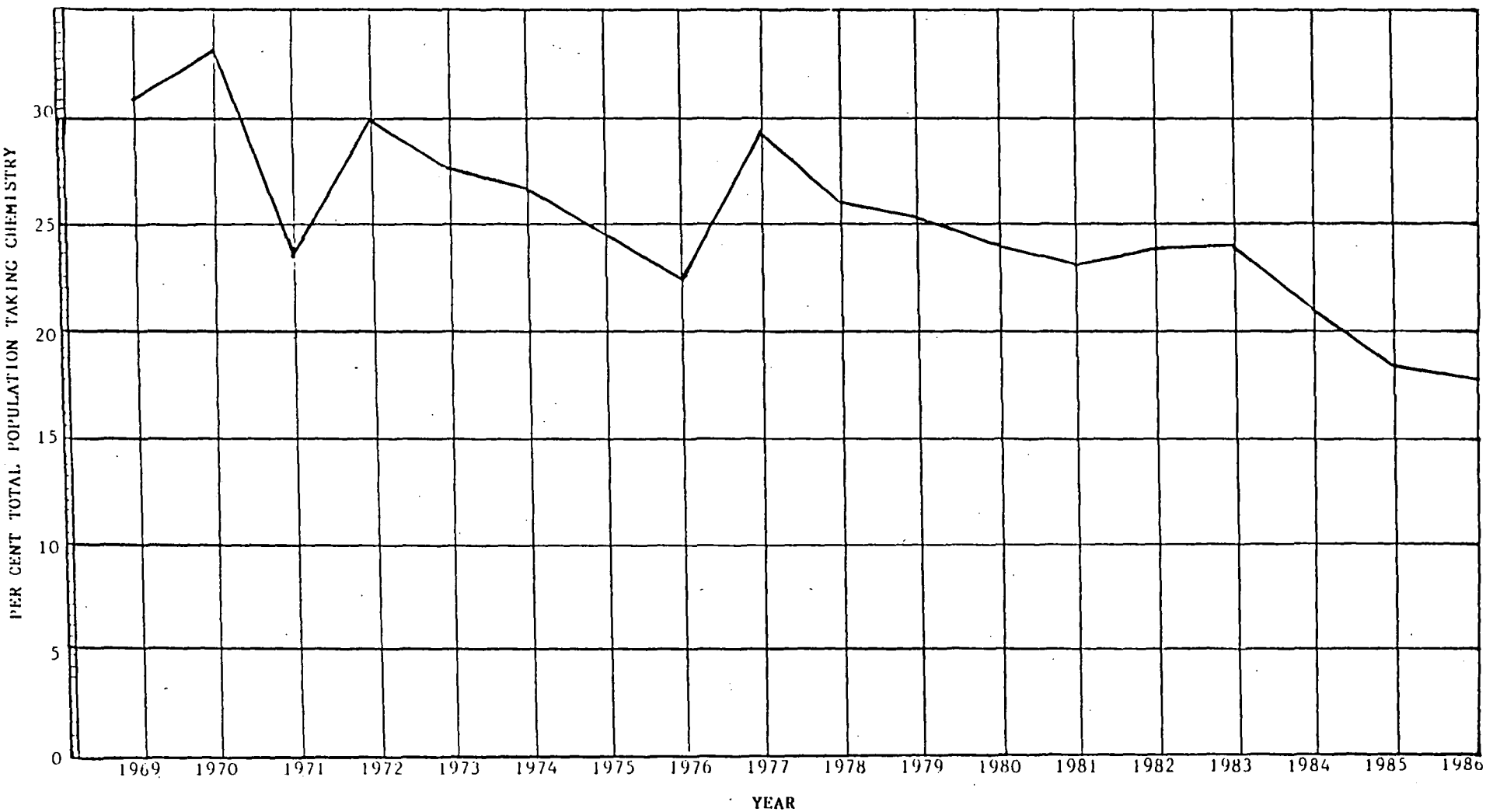
TABLE 1

ENROLMENTS AT CHEMISTRY HSC 1969 ONWARDS

YEAR	TOTAL ENTRY	CHEM III	%	CHEM II	%	CHEM A	%	CHEM B	%	CHEM STUDY III	CHEM STUDY III DIV	CHEM STUDY %	CHEM A	%	TOTAL	%
1969	3121	749	23	238	7.6										987	30.6
1970	3618	824	22.7	434	11.6										1258	33.6
1971	4108	542	13.2	11	-					292	123	7.1 2.9			968	23.5
1972	4473	238	5.3	12	-					482	618	10.8 13.8			1350	30.11
1973	4512	21	-	4	-					643	592	14.2 13.1			1260	27.9
1974	4551			6	-					630	586	13.8 12.8			1222	26.8
1975	4691			4	-					595	563	12.6 12.0			1152	24.7
1976	4699									557	458	11.8 10.3			1042	22.1
1977	4808					966	20.1	193	4.0	206	55	4.2 1.1			1420	29.5
1978	4842					874	18.0	291	6.0	26	73	- 1.3			1264	26.1
1979	4789					906	19.0	251	5.2				69	1.4	1226	25.6
1980	4648					840	18.0	231	5.0				45	1.0	1116	24.0
1981	4594					786	17.0	229	5.0				46	1.0	1061	23.1
1982	4407					753	17.0	228	5.0				89	2.0	1070	24.2
1983	4988					881	17.6	233	4.7				88	1.7	1201	24.0
1984	5356					810	15.0	215	4.0				102	2.0	1127	21.0
1985	6086					769	12.6	191	3.1				148	2.4	1108	18.1
1986	6543					763	11.7	217	3.3				167	2.4	1147	17.4

FIGURE 2 : GRAPH OF PER CENT HSC CHEMISTRY STUDENTS

OF TOTAL POPULATION FOR YEARS 1969 - 1986



constant (3 to 5%) population of students opting for Chemistry B in Year 12. Although not a pre-requisite for tertiary study, Chemistry B has always been recommended by the Colleges for students wishing to go on to a higher level science course.

A report from the University of Tasmania[21] shows that enrolments in Science have remained fairly stable from 1973 - 1985. Although showing a slow decline, chemistry has fared comparatively better than physics or mathematics. In addition it would appear that almost all students who pass Chemistry B at HSC Level enrol in one, or other, of the first year chemistry courses at the University. Tables 2 and 3 show the figures in EFTS values.

Whilst it may appear that the situation regarding Chemistry in Tasmania is quite healthy compared to many overseas countries, and mainland Australia, there are no grounds for complacency and figures of approximately 1000 chemistry students, per annum are, after all, rather insignificant. It must also be taken into account that Tasmania has the lowest retention rate into grade 11 of all the States.

TABLE 2

ENROLMENTS IN SCIENCE AT UNIVERSITY OF TASMANIA

YEAR	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR +	HONOURS	MASTERS QUALIFYING ETC	TOTAL UNDERGRAD	POSTGRAD	TOTAL
1973	341.48	169.59	146.77		35.00	5.09	697.93	140.00	837.93
1974	331.62	154.23	123.21		48.38	7.93	665.37	147.21	812.62
1975	320.27	128.85	107.42		40.20	14.15	610.89	127.50	738.39
1976	314.11	160.62	115.87		41.37	10.31	642.28	139.00	781.28
1977	290.81	164.06	144.64		39.40	12.24	651.15	167.50	818.65
1978	278.93	166.09	149.58		44.68	7.97	647.25	186.00	833.25
1979	287.02	148.47	130.43	5.66	31.50	1.50	604.58	196.00	800.58
1980	295.49	132.37	128.83	10.35	61.50	2.00	630.54	189.86	820.40
1981	322.99	154.03	112.57	4.93	52.50	3.50	650.52	182.19	832.71
1982	321.07	177.29	128.96	4.31	45.00	7.67	684.30	190.37	874.67
19 3	365.65	185.06	150.11	7.20	54.50	8.50	771.02	207.95	978.97
1984	345.02	168.49	144.78	12.65	58.75	9.00	740.01 +	217.04	957 +
1985a	344.80	175.71	150.24	5.50	65.00	8.50	749.77	281.67	1031

\+ Figure includes 1.15 non-departmental faculty WSU

(a) Concurrent undergraduate with post-graduate enrolment is included in undergraduate figures

TABLE 3

ENROLMENTS IN CHEMISTRY AT UNIVERSITY OF TASMANIA

YEAR	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR +	HONOURS	MASTERS QUALIFYING ETC	TOTAL UNDERGRAD	POSTGRAD	TOTAL
1973	70.36	19.76	9.02		6.00	0.50	105.64	20.50	126.14
1974	65.43	21.19	10.86		2:00	2.00	101.48	25.00	126.48
1975	56.19	17.31	8.68		2.00	1.00	85.18	17.00	102.18
1976	58.77	14.64	10.52		3.00	1.50	88.43	16.00	104.43
1977	54.60	21.90	10.70		7.00	1.50	95.70	19.50	115.20
1978	50.35	26.95	9.69		2.50	1.00	90.49	23.00	113.49
1979	51.34	21.60	8.19		4.50		85.63	26.00	111.63
1980	55.01	18.22	14.21	0.67	4.00	1.00	93.11	16.96	110.07
1981	54.21	19.16	10.54	1.04	8.50	1.00	94.45	19.97	114.42
1982	56.57	16.69	12.85		2.00	1.50	89.61	26.72	116.32
1983	57.88	19.79	12.59	0.00	7.00	1.00	98.26	33.00	131.26
1984	57.23	19.72	11.66	0.00	10.00	2.00	100.61	33.10	131.71
1985	58.78	21.87	9.58	0.75	7.00	0.50	98.48	50.86	149.30

In summary there does not seem to be a major decline in the number of students taking the subject over the last decade. It must be stated, however, that the total number of students taking Year 11 and 12 subjects other than Chemistry has increased dramatically which means the actual percentage of students taking Chemistry has declined. This has occurred during a period of time when

i) there has been a virtually complete drop off in student numbers taking chemistry as a separate subject in High Schools and

ii) there has been a proliferation of new subjects at the HSC level. This speaks well for the teaching at this level and suggests the changes in curriculum, and approach, over the same periods, have on the whole been effective. These changes will be discussed in detail in the following Chapters.

CHAPTER TWO

CHANGES TO THE CHEMISTRY CURRICULUM IN TASMANIA 1966-1985)

2.1 THE TRADITIONAL SYLLABUS

On my arrival in Tasmania in 1966, I was given a copy of the current Tasmanian 'A' Level syllabus. It was, in many respects, similar to the UK two-year A-Level syllabus that I had been used to but contained only about two thirds of the UK topics and was particularly lacking in carbon chemistry. It wasn't until about two weeks later I found out it was a one year syllabus!

This highlights the major problems of the old traditional syllabus namely, the favouring of rote learning as a consequence of far too many prescribed topics. Students were even required to learn the name, symbol etc of the first thirty-six elements of the periodic table. The inorganic section consisted of extraction, properties, uses and important compounds of the major groups and was partly tested by examination questions asking for the balancing of several esoteric equations. The physical chemistry section listed a large number of molecular weight determinations, the usual gas laws, etc, and the organic section was mainly the chemistry of selected aliphatic homologous series, with a brief mention of aromatic substances. The Corresponding Tasmanian 'O' Level syllabus was simply a condensed version of the 'A' Level syllabus.

At the end of a year, a student's result was decided solely on the external theory and a practical examination, and there was no form of internal assessment. The practical examination consisted of a volumetric exercise and qualitative analysis of a two-radical inorganic substance.

Because of the nature and large content matter of the course, teaching was carried out lecture-style with little or no time

for discussion of the underlying principles. The student population was definitely an elite group and all students had done Chemistry as a separate subject at the four year High School, covering many of the topics to be found in the 'A' Level syllabus. Most colleges ran a full afternoon practical session and most of this time was spent in repetition of the quantitative and qualitative exercises as found in the external practical examination. This is based on the experience of Senior Masters during the period but is not documented.

It was amazing that so many students achieved pass standard in such a short time but I feel this would not have been the case if the subject had not been previously covered, at considerable depth, in the High School.

In the North of the State, it was standard practice for over 80% of the students to repeat Chemistry in Year 12 so as to improve on the mark gained the previous year. This in some cases led to the introduction of "Sixth Form Classes" where teachers risked not covering some of the factual chemistry and actually tried to explain the underlying concepts, carry out more interesting experimental work and discuss topics, as opposed to the straight lecture approach. Students in these

classes usually gained a much higher mark in their second year and most went on to study the subject at University. Whether because of the new found freedom from, in those days, the strict regimen of the Colleges; the different teaching techniques; or the much larger classes the attrition rate from Year I to Year II at the University was phenomenally high.

In 1966, during the May holidays, a residential seminar was held at the Univesity for all interested 'A' Level Chemistry teachers. This was well attended but not well received. At that time the relationship between the teachers and the staff of the University Chemistry Department was far from being the excellent one it is these days and the seminar consisted mainly of the University staff telling the teachers how they ought to teach the various topics - a system that resulted in several violent disagreements. Luckily, the residential nature of the course led to some good results. Discussions at Christ College lasted late into the night and, fortified by generous amounts of ethanol, the teachers decided the time for change was ripe. Senior teachers such as Syd Eldridge (Hobart), Graham Fish (Launceston) and Father O'Ryan (Burnie), ably assisted by many others, started collating evidence for the introduction of a new syllabus and entirely different approach to the teaching of the subject in Years 11 and 12.

2.2 The Search for A Replacement Syllabus

At a seminar, convened by the Supervisor of Science, J Scott, held in Hobart, Australia in 1969, the major theme concerned new courses in chemistry being used by the mainland states. Visiting speakers[22] included K Lee Dow from Victoria who outlined the new syllabus based on the CBA approach; C Dettrich from Queensland, where Chem Study had been trialled; V Ayres, South Australia, where an original syllabus was being used; and C Messel NSW. Consensus of opinion was that the Chem Study approach would be more suited to Tasmanian students and a proposal for its adoption as a trial course was put to the Schools Board Chemistry Subject Committee.

As mentioned earlier, an external practical examination was taken by all Level III students and usually consisted of a volumetric exercise and qualitative analysis of a simple inorganic substance. This meant that students spent a major portion of their practical time practicing such exercises. At the end of the year, the practical examination was held in various centres around the State. Solutions and substances were sent by the University to these various centres and the

local teachers were responsible for the setting up of apparatus, supervision, checking of papers and other headaches associated with such projects. At the larger centres this usually stretched over several days and involved several separate examination sessions to cover all the students. The problems caused did not seem to merit the low weighting given to the practical examination and in 1968 it was replaced by a two-hour theoretical practical examination! This proved to be a disaster with adverse criticism from both teachers and students and was abandoned in 1969[23].

2.3 The Introduction of Chem Study 1969

During this same year, 1969, approval had been given for three trial classes to be held using the Chem Study approach[22]. The three classes were run by Graham Fish (Hobart), Father R Brown (Marist College, Burnie) and myself, (Launceston). The latter two teachers were co-opted to the subject committee[22], whose chairman was Graham Fish, for the purpose of giving regular reports on the progress of the trial classes. The classes were to be at Level II standard and the syllabus consisted primarily of the first thirteen chapters of the text, Chemistry: An Experimental Science, Freeman and its

associated practical manual. All other centres were to be invited to conduct classes using the Chem Study approach in 1970.

I always have felt that I was chosen to conduct one of the trial classes in order to fill the role of "devil's advocate". In the preliminary discussions I had not been in favour of introducing Chem Study and had been more sympathetic towards the CBA approach as used in Victoria and modified in Stranks' Chemistry, A Structural View. This attitude was to change during the trial year and I now sincerely feel that the Chem Study approach, as modified several times, has helped arrest the decline in the numbers of students taking the subject in the State.

By December 1969 the "unprecedented interest"[25] shown in the Chem Study course and the greater student intake in some schools, led the Chemistry Subject Committee to give permission for schools where the number of students opting for the alternative Level II course exceeded the maximum practicable for a teaching group, to form further teaching groups in the course.

Because of the high interest shown by all teachers a seminar

was held in August 1969 at the University. It was attended by thirty teachers of HSC Chemistry in Tasmanian Schools and led by Brother R Slattery from Townsville[26]. He opened proceedings by discussing the major advantageous teaching strategies to be found in the CHEM study course:-

i) the course combined continuous development with an appeal to the natural curiosity;

ii) students should be brought to the point where the answer is "I don't know";

iii) students become sensitive to the progress of science;

iv) students must go beyond the information given;

v) science teaching keeps up with development; and

vi) practical work does not follow a "cook-book" procedure but is of an investigational nature.

He then pointed out certain new issues that arose as a consequence of using such strategies:

i) the teacher needs more time to prepare and needs assistance with preparation of materials;

ii) more equipment and supplies are needed;

iii) the laboratory must be accessible to teachers at all times; and

iv) the teacher needs training in the different approach to the subject.

Luckily, the system in Tasmania, where many students attend post-secondary colleges, meant that most of the criteria could be met. The college system in Tasmania recognises the fact that teachers do much more than just teach a class in a particular subject. Staff are given a generous non-teaching time allocation on their timetable. This meant valuable time was available for preparation of the new syllabus. All colleges have a fully trained laboratory technician who proved invaluable in the early stages in preparing new solutions and making chemicals, apparatus etc available for the classes.

Because large classes were running in chemistry, money was available for new equipment. The colleges had ample laboratory space, in most cases, to enable all practical classes to be held in specialist rooms and possibly the most important fact - the several staff members could get together, discuss the problems of the new approach and help one another come to a solution. The excellent co-operation between all teachers has led to the bigger centres helping the smaller ones, ideas being exchanged, equipment loaned, films have been readily available etc.

The remainder of the seminar consisted mainly of the original trial teachers giving their impressions of the course, problems encountered, student attitudes, and feelings about the course in general from a working point of view. Compared to the traditional course the teacher work load was much greater but for the student it consisted of a continuous stream of <u>regular</u> work, such as reading, laboratory reports, and problem assignments, as opposed to the <u>irregular</u> heavy work, particularly at revision time, experienced previously. Problems in testing and assessment were fully covered, also the new texts available and both these facts will be discussed in later sections. Overall, the seminar had proved most stimulating for all teachers concerned and there was a general

feeling of optimism regarding the adoption of the new course.

Figures quoted in Chapter 1 show an increase in the number of students taking Chemistry II from 238 to 434 from 1969 to 1970. Some of these students would still have been studying the old Level II course but the majority would have been using Chem Study eg in 1971, 292 students attempted the first Level III open book Chemistry examination out of a total of 968.

2.4 The Change from Chemistry II to Chemistry III Division I

The possible stigma attached to the Level II status*, ie the fact that the majority of students preferred to attempt a subject at Level III, was removed in 1971 by renaming it Level III Division I. The subject was still fully internally assessed at this level and students still needed a full two years of study before they were able to attempt the Level III external examination. This placed the student at a considerable disadvantage compared to many other subjects, particularly in the Humanities, and marked the start of the steady decline in numbers entering Chemistry over the next five years.

* Level II did not, in most cases, count towards tertiary entrance and was recommended for students with a weaker background in Science and Mathematics.

Admission to tertiary institutions, particularly University, was based on a students' overall performance. The Chemistry Level III Division I only carried a Level II status and could not be counted once the subject was passed at Level III in the second year. The content, and standard of work required in Chemistry Division I was on a par with most other full Level III subjects yet after two years work the student only gained one Level III pass whereas most other students, over two years would have gained two Level III passes on other, different, subjects. Only Physics and Chemistry students were placed in this invidious position.

Also, at this time, permission was given for the new generation texts to be used as set books (see later section). Progress of students during the year was to be monitored by compiling a list of scores of all students, from all different centres, in the set achievement tests. In addition, an item bank was to be prepared consisting of original multiple choice questions drawn up by teachers from all over the state (covered in a later section). Further helpful progress was made at a seminar held in 1971. General discussion of the new course had helped teachers who were new to the concept and in addition an analysis of the examination papers was conducted by Dr B V O'Grady. This had revealed weak areas such as gas

law equations and concepts in carbon chemistry. These matters were discussed with HSC teachers and suggestions for improved coverage were moved.

By 1972 the new subject was well established with 618 Division I and 482 Level III students enrolled compared with only 250 taking the traditional course. It had become fairly obvious that the coverage in Division I was too much and so the section on oxidation - reduction was removed from the syllabus and transferred to Level III[27].

In 1973 Chem Study was finally adopted as the only Level III syllabus, and no longer carried the label "Alternative". The 1973 examination was sat by 643 candidates, and 592 were internally assessed at Division I. However only 21 candidates had taken the traditional course compared with 238 the previous year and this represented a significant drop in overall figures. The Chief Examiner expressed concern[28] at the low standards of mathematical competence of many students and in future years the HSC Manual carried a list of mathematical skills required by students as a pre-requisite for the syllabus. University staff were still concerned about certain sections of the course and teachers were to be asked to treat sections on the Periodic Table and Chemistry of

Carbon Compounds in greater depth than shown in the texts.

2.5 The Changes to Chemistry A and Chemistry B

Numbers continued to drop in 1974 and 1975. The Chief Examiner, Dr O'Grady, produced a graph of entries showing the steady drop in numbers over the previous years. In a scientific 'sleight of hand' he extrapolated the graph to 'prove' there would be no students taking Chemistry by 1985. Luckily his prediction proved wrong but at least it resulted in action. The decline in numbers was thought to be mainly due to the two year study requirement for a Level III pass. The same situation applied in Physics and so the proposal was put forward that students taking both Chemistry Division I and Physics Division I be allowed to sit a Physical Sciences Level III examination at the end of their first year[29]. Representatives from both subjects committee were to meet and discuss this proposal. The decline in numbers was now the topic of much concern and in addition to the above proposal the possibility of upgrading Level III Division I to Level III status was first put forward. The unfavourable position of Chemistry compared to most other subjects both in amount of work covered and the lower pass rates led to the following

statement being forwarded to the Schools Board of Tasmania:[29]

> "The Chemistry Subject Committee respectfully draws the attention of the Schools Board to the low percentage of Higher School Certificate passes in Chemistry subjects, that are studied by a majority of students over 2 years, in comparison with much higher pass rates in many other subjects that are only studied for one year and requests the Schools Board to investigate the position in other Australian States. In Tasmania, in Chemistry, students have to work harder and longer with less chance of passing than in most other subjects!"

No wonder numbers were declining!

At this time the idea of a joint Physical Science subject was sabotaged when it was discovered that the Physics Subject Committee had proposed separate Physics A and Physics B syllabi both to have full Level III status. Chemistry teachers were then circulated to obtain their views and there was general agreement that Chemistry should pursue the same course and develop two separate syllabi in Chemistry and that Chem Study was the best available course on which to base these syllabi. At a meeting of the Subject Committee[30] the

following points were made:-

i) Chemistry A should be a pre-requisite, or a co-requisite, for Chemistry B; and

ii) Chemistry A and Chemistry B should each aim to cover different subject material but one syllabus should not necessarily be at a more advanced standard than the other.

To this end, a Sub-committee was established to prepare a Chemistry A and a Chemistry B syllabus based on the Chem Study course but without necessarily precluding other materials.

The committee consisted of myself, E Denney, A Denny, and M Horsham; all practicing HSC teachers. The usual 'band-aid' approach was applied and teachers were expected to carry out important curriculum changes in their own time and without any expert guidance. This has always been a major problem in Tasmania, not confined only to Chemistry, in that any changes to curricula are usually instigated by teachers, passed to the respective Subject Committee whose members are then faced with the task of drawing up a new syllabus, guidelines,

specimen papers etc in their own time. Some guidance is available from the Curriculum Centre but at times less mistakes would be made and progress would be more rapid, if concerned teachers could be seconded to work at the particular task.

The four members of the Sub-committee met in Launceston for two days during the 'swot-vac' period - the time when students in the colleges have left to revise for, or sit examinations, and therefore no formal classes are held. The syllabus was reviewed as a whole and then sub-divided into sections; one for Chemistry A and one for Chemistry B. This caused several problems:

i) the majority of students, of the order of 75% as subsequent entries show, would only study Chemistry A. This meant this subject had to function as both a terminal course and a foundation course for Chemistry B;

ii) it was found to be virtually impossible to include enough material to make Chemistry A a good terminal course. This has possibly been the major criticism since the two courses were

introduced. Several topics were just not covered in the Chemistry A syllabus and consequently many students were finishing a year of Chemistry with an incomplete coverage. This proved to be a major problem for those students who went straight to University after year 11. As the only pre-requisite laid down by the university was a Chemistry A pass it was left to teachers to strongly recommend Chemistry B as a 'required subject' for study at University;

iii) some topics included in Chemistry A have since proved to be, conceptually extremely difficult for year 11 students; and

iv) it was a major problem to divide the course in two halves which made approximately the same academic demands. It would be generally agreed that the Chemistry B course requires a higher mathematical level and possibly a more mature approach.

Nevertheless, the two syllabi (Chemistry A and Chemistry B)

were drawn up and a case prepared for the adoption of the two subjects.

In the meantime, the entries in Chemistry were still falling! One reason suggested by the Chief Examiner, Dr O'Grady, was that the examination itself was too long. He suggested ways to overcome this and these will be discussed in a following section.

At the next meeting[30] it was 'all systems go'. New specimen papers were to be drawn up, internal assessment was to be introduced and applied to a system of options and the case for Chemistry A and Chemistry B presented to a meeting of the Higher School Certificate Committee. This was ably carried out by Messrs E Denney and A Denny.

The internal assessment component was introduced to bring Chemistry into line with other subjects which had internal assessment components ranging from 25% to 75%. Because several members of the Subject Committee felt the external examination was the best form of assessment, it was decided that Chemistry would be limited to an internal assessment of 15% only. This was to be trialled in 1976 using the existing syllabus and taking into account a single unit of the course

which took approximately four weeks and be essentially on practical work, but that a theoretical understanding of the unit of work chosen be also taken into account. For the new Chemistry A and Chemistry B courses a choice of options would be prescribed in the respective syllabi (see later).

The two new syllabi were introduced in 1977 and as earlier figures show there was a dramatic rise in numbers taking Chemistry: 206 students took the old Level III, 966 (the highest numbers recorded so far) sat for Chemistry A, and 193 took the first Chemistry B examination. This represented a nearly 8% increase in students studying Chemistry. In the eight years since the introduction of Chemistry A and Chemistry B, figures overall have remained fairly constant, percentage wise, and the alarming drop in the period seemed to have been arrested.

In the years 1977-1985 only minor changes have taken place in the two syllabi. The Subject Committee has continued to work hard, however, and there has been considerable work done in the area of the examination itself; options; internal assessment and the Level II syllabus (covered later). At Level III the emerging pattern is that about 1 in 4 students take Chemistry B after studying Chemistry A. Because nearly

all students taking Chemistry B had already gained an award in Chemistry A it was felt that pass rates for the former should be higher and this is now standard practice.

The practice, by a small percentage of students, of taking Chemistry A in their second year ie whilst also studying Chemistry B, in order to improve their mark in Chemistry A was a cause for concern. The students were usually 'high-fliers' often intending to enter Medicine and they simply sat the examination in Chemistry A using their option mark from the previous year. This practice was finally outlawed in 1985-86 because it was genuinely felt that it was penalising Year 11 students. This accounts, in a large amount for the drop in Level III numbers over these years. In addition there has been a steady increase in numbers taking Level II for reasons discussed later.

By 1985 it was thought that the conceptual nature of the Chem Study Course had its drawbacks. Many chemistry teachers, both overseas and in Australia, bemoaned the fact that there was little "real" chemistry in the course. The Chem Study course had a strong bias towards physical chemistry and the Tasmanian situation meant that students who only studied Chemistry A met no organic chemistry and very little

inorganic chemistry. There had been a world-wide support for more meaningful chemistry to particularly cover such aspects as industry and the environment. Work overseas and on the mainland of Australia had resulted in many new courses being developed. In particular the Australian Academy of Science course was interesting teachers in Tasmania. The next chapter will deal with this course and its final adoption in the State.

CHAPTER THREE

THE AUSTRALIAN ACADEMY OF SCIENCE COURSE - "TO BE OR NOT TO BE"

3.1 The Project Committee

In 1974 the Australian Academy of Science formed a School Chemistry Project Committee to inquire into secondary school chemistry teaching in Australia. Dr Peter Simpson was appointed Project Investigator in 1975 and the following year presented a report entitled "The Teaching of Chemistry in Years 11 and 12 of Secondary Schools in Australia". This led the Academy to embark on a program to produce a suggested course of study for senior secondary school chemistry.

By 1977 a new Project Committee had been established which contained representatives from all states in Australia. The group was widely representative and contained members from the secondary and tertiary sectors, as well as chemists working in industry and research institutes.

The syllabus produced by the Project Committee contains material which is teachable in about two years, provided that the notes about depth of treatment are observed and provided some previous exposure to chemistry can be assumed.

The last assumption has been particularly problematical for the Tasmanian group. It is generally agreed that the chemistry content of High School Science Courses in Tasmania is somewhat meagre. In addition, the feeder schools which supply the majority of students to the Colleges do not have a prescribed course and each pursues its own treatment of chemistry which is very varied. As any HSC class in Chemistry can contain students from up to eight different feeder schools this raises obvious problems as a consequence of varied 'preparedness'.

The problem was partly overcome with the Chem Study course in that that course assumed little or no previous knowledge of

basic Chemistry. Because of the varied approach in the feeder schools some students had done a reasonable study of some topics and when these topics were met in the Chem Study course some students complained they were bored by going over the same ground again; some students had done some of the experiments previously; some students had seen some of the films; and a smaller group had done no chemistry at all. This caused obvious dissatisfaction but there seemed to be no clear solution to the problem unless a common content was covered in all High Schools.

3.2 The Visit to Tasmania of Dr Simpson (Australian Academy of Science

In 1978 the Academy distributed a draft of the new syllabus and this was followed up by a visit from one of the Project Officers to each state. The report[31] makes some very interesting points:

i) Tasmania has special problems, many of which stem from the university entrance requirements;

ii) It is difficult to see major changes in chemical education in Tasmania before a number of serious problems are attacked; and

iii) The present courses in lower secondary science are a major curriculum problem.

Dr Simpson formed these, and other, opinions as a result of two meetings held in Tasmania. The Hobart meeting was dominated by tertiary teachers but the Launceston meeting involved only secondary teachers from Launceston and the NW Coast centres. No high school teacher responded to the invitations to attend. Dr Simpson noted that it was clear that uncertainty existed in the colleges concerning the lower secondary science and the chemistry experiences of the students entering HSC classes.

> "Perhaps because of the absence of first class teaching materials, and sometimes because the teaching of science in high schools is often the responsibility of biologically trained teachers who are insecure in the chemistry and physics areas, chemistry is often neglected and in some cases almost completely omitted

in the last two years of high school" (Dr Simpson's words, not the author's).

In other high schools the chemistry taught is a "watered down" version of the Chem Study syllabus which tends not to inspire the interest of the students nor to have the stamp of relevance. In 1978 Dr Simpson suggested that it was certainly time in Tasmania, as in almost every State in Australia, that a consensus was reached about the Chemistry content of science courses in the lower secondary school. Although several good suggestions have been put forward in the intervening years the situation has not improved greatly. The proposed introduction of a single Certificate of Education covering years 9-12 may help overcome this problem.

Other points raised in the Simpson report are:

i) The pass-fail criteria used for tertiary study often causes students to choose subjects with less able sub-populations where the chances of passing are improved;

ii) A reappraisal of the university entrance requirements is needed and possible other

scaling procedures should be adopted/explored; and

iii) The present Academy draft syllabus would find application in its present form only following an agreement that its philosophy and some of its content were to become the core of a four year high school chemistry experience.

All of these points have been repeatedly discussed in Subject Committee meetings, Chemistry Discussion Group meetings, various seminars and in many staff rooms, but in 1986 many of the problems were still largely unresolved.

3.3 Work in Tasmania towards the Introduction of the Academy Course

Neverthless, the Subject Committee decided that the time had come to tackle the problems head on. It was obvious there were many deficiencies in the present Chem Study course. Could the Academy Course be adapted to overcome some of these problems?

A seminar was held in December 1983, at which HSC teachers were given an outline of the Academy course by Dr Bob Bucat, the supervising editor of the associated texts. This showed limited support for the new Academy course, and it was decided that a Chemistry Discussion group meeting would be held to prepare ideas for a major seminar in 1984. As a result of these discussons, I undertook the task to arrange a major residential seminar in the period immediately after the HSC Chemistry examinations had finished. Co-operation from all sides was excellent. The presence of members of the Education Department, Private Schools, the Schools Board, the University of Tasmania and above all, practicising teachers, ensured the seminar was a success.

The venue was the University of Tasmania, and the seminar ran from December 10th - December 13th inclusive. It was intended to provide a forum for informal and wide-ranging discussions on HSC Level Chemistry and all related matters[32]. This was in response to widespread feeling that the existing HSC chemistry syllabi no longer met present-day needs in chemistry nor the changing trends in education for Grades 11 and 12, and in the post secondary sector.

That the meeting was so well attended from all areas of the State, and all sectors of education, indicated both the extent of such concerns, and a willingness by all to work together to find solutions. One noticeable absentee was the convenor who was confined to a hospital bed, but my position of chairman was ably filled by Terry Shadbolt of Hellyer College.

A listing of the papers presented will give an idea of the scope and depth of discussion:

i) "Taking Stock" - by Dr Barry O'Grady

ii) "Some Observations Regarding Chemistry Teaching in the UK and their Implications" - by Dr Paddy Lynch

iii) "The Examination - Closed or Open Book" - by Dr Alan Canty and Ewan Denney

iv) "HSC in Other States" - by Graham Fish

v) "The Academy of Science Texts" - by Graham Fish on behalf of Bob Bucat

vi) "What Other Disciplines Think . . . ." - the chemical knowledge needed in HSC Biology - by Lloyd Mulcahy, the situation in HSC Mathematics - by Michael Cole - the situation in HSC Physics - by John Gora

vii) "Matters for Discussion" - by Warren Howlett

viii) "Practical Work and its Assessment" - by Paul Webb

ix) "The Place of Level II Chemistry and Other Unitised Courses" - by Mike Moreton

x) "HSC Chemistry A: The Present Situation" - by Tony Denny

xi) "Towards a New Level III Chemistry" - this was the final discussion topic and led to several resolutions. These showed the need for immediate action and include the following:

a) That in any new course Chem A/Chem B type two year structure be retained

b) The meeting in principle supported the philosophy, objectives and aims as outlined for the Academy Course

c) That selection be made from within the Academy texts of courses suitable for Chem A and Chem B using those texts as reference material

d) That a State-wide syllabus committee be established to consider all suggestions made and further develop a syllabus.

To encourage participation by practicising teachers, regional sub-committees were established to look at various sections of the content. These were then considered by the Subject Committee[33] who tabled a new "first-year" syllabus. It was agreed that copies be sent to all centres; comments solicited from practicising teachers and further work be carried on with a view to introducing the new syllabus at Year 11 in 1987 and Year 12 in 1988. Several sub-committee meetings, and a meeting with a mainland teacher using the new course had led to more refinements.

At the 1986 meeting[34] this was formally proposed as the new Year 11 syllabus for 1987. Aims, philosophies and objectives have been drawn up: a specimen paper prepared: and guidelines for assessment drawn up. At the time of writing (July 1986) the new course is awaiting ratification by the Schools Board. If passed, work will be started on finalising the content for the Year 12 syllabus. The two subjects will be renamed Chemistry III and Advanced Chemistry III.

The exercise detailed above shows the excellent co-operation between HSC teachers, University educators and the Schools Board and reflects the healthy state of the subject in Tasmania. All teachers have been informed, via the Subject Advisor that the Academy texts were to be viewed as a Student Reference Text and that teachers should be free to develop their own teaching strategies. Support seminars are to be held: resource material prepared and teachers kept informed of all progress.

FOOTNOTE

In 1987 the new Chemistry III course was adopted as the only Year 11 Level III Course in Tasmania. The Year 12 Advanced

Chemistry III commences in 1988. There has been little chance to study the effects of the new course on numbers, pass rates etc, but student and teacher response is initially favourable.

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CHAPTER FOUR

THE PRACTICAL COMPONENT OF HSC CHEMISTRY: TWENTY YEARS OF CHANGES

4.1 The Practical Examination

In 1966 students took an external practical examination as well as a three hour theory paper. This point is discussed in some detail in Chapter 6.

In nearly all cases the practical examination took the form of a volumetric exercise and qualitative analysis of a two radical inorganic substance.

Because of the format of the practical examination teaching

was slanted towards practice for the examination and very little other practical work was attempted. Most schools devoted at least one full afternoon a week to practical work during which time students slavishly practised volumetric and analytical techniques. One school even extended this period and students were 'allowed' to work until five o'clock.

This was the picture when I arrived in Tasmania and, to be fair, a similar situation existed in Chemistry classes in the UK. One surprise however was to find that macro-techniques were still being employed and, being given permission to introduce the semi-micro techniques, one of the major problems overcome to bring about this change was to find an Australian firm that sold semi-micro centrifuges.

At the end of the year, the practical examination itself was held at the various centres around the State. Solutions, and unknowns, were despatched in sealed boxes by the University with strict instructions that they were not to be opened until the day of the examination. The resulting panic if anything was missing caused many chemistry teachers to turn grey! The centres were required to provide laboratory space, apparatus and reagents. With large numbers of candidates at some centres, this meant the process was spread over several

days and caused major disruptions to the lives of both students and teachers. Supervision was carried out by the teachers themselves who received a modest fee for their services.

The type of practical examination used in the period led to a very narrow coverage of practical work. In spite of the fact that it carried only a small percentage of the overall mark it resulted in a great deal of extra work for both the University and the schools. In 1968 it was replaced by a second theoretical paper based on practical topics. This second paper was to be "a written paper of two hours duration, emphasising the practice of chemistry." This proved a disaster with most students not being able to cope with doing a written practical exercise - not surprising! All teachers were adverse in their criticisms of the new concept and it was wisely abandoned after the one attempt.

4.2 Practical Work as an Integrated Part of the Course

In 1969, with the introduction of the three trial classes in Chem Study, students taking the new course were exposed to a whole new concept in practical work. The new course had its

own laboratory manual and as stated in its preface (the Text "Chemistry: An Experimental Science" by Freeman).

> "The CHEM study course approaches the study of chemistry as an experimental science. It is a laboratory-centred course which:
>
> i) features experiments which will permit you to make your own discoveries of the regularities and principles which unify Chemistry and make it easier to understand;
>
> ii) emphasise the making of careful observation and quantitative measurements under controlled experimental conditions;
>
> iii) stresses the preparation of well organised tables for recording data and the results of calculations so that you can more readily make deductions and recognise the regularities which exist;

iv) Uses challenging discussion questions which will help you to apply principles, observed in the experiments, to new situations.

The Textbook discussions are closely meshed with the laboratory work. Each chapter in the Textbook is proceeded by one or more experiments which provide an experimental background for the topic discussed. As you learn to recognise and use the important principles you will be in a better position to appreciate and understand the theories which have been proposed to explain the regulations in chemistry[35].

This new approach was a tremendous improvement appreciated by most students and all teachers. The work load on staff, particularly laboratory technicians, proved considerably greater than had been expected but over the years has lessened as departments became more organised.

Some teachers still felt that not all the experiments in the new course were suitable and a list of alternatives was drawn up by the Schools Board and distributed to all centres in 1970[36].

By 1972 the new CHEM study course was well established but it was felt that not all centres were fulfilling the practical requirements and so the following statement was made part of the Schools Board Handbook: -

> "All candidates presenting themselves for examination in Chemistry must have completed a course of practical work in a laboratory which has been approved by inspectors appointed by the Schools Board of Tasmania.
>
> This course should comprise suitable qualitative and quantitative experiments reasonably distributed over the syllabus, and the experiments must be the *individual* work of each candidate. No more than half the practical time should be devoted to analytical chemistry. Other practical exercises are to be based on the coverage of the physical, inorganic and organic courses.
>
> Suggested minimum times for laboratory work are:
>
> Level II: 30 hours per year
> Level III: 50 hours per year.

> For practical classes it is suggested that the number in the class should *not exceed sixteen*.
>
> At the end of the year the teacher will be required to award a mark to each candidate for the work performed during the year. This mark *may* be taken into account in evaluating candidates for the award of grades for the Higher School Certificate Examination"[37].

The italics are the author's and show areas where the letter of the law has not been strictly obeyed. The practice was and still is that most experiments are carried out by students working in pairs or small groups; most classes in the Government schools would be well over sixteen. Until 1976 the practical mark was not used for assessment purposes (discussed in detail in Chapter 6).

In 1972 a further resolution was made that:

> "the results of achievement tests and a mark for skills in practical work would form a suitable component for teacher assessment at Higher School Certificate Chemistry. The weighting would be 30-40%"[27]. This resolution was not acted upon until 1976. In that year

it was decided to make the internal assessment 15% and even then it was only to be conducted as a trial. The resolution was that:

i) the Subject Committee request approval to trial an internal assessment component of 15% in 1976;

ii) schools be requested to provide an assessment of a single unit of the existing Chemistry course which takes approximately four weeks;

iii) the school assessment be based essentially on practical work but that a theoretical understanding of the unit of work chosen be also taken into account"[38]

4.3 The Introduction of Options

This move paved the way for the official introduction of optional topics into the course. It had been felt for some time that although, a major improvment on the old course, the

new course was biased towards physical chemistry and that students were not handling enough "real" chemicals. The Chief Examiner Dr B O'Grady, made much of the fact that students thought that:

"silver chloride was a green gas".

Whether this was a direct quote from an examination answer or a plagiarism was not the point - the problem did exist and students could and did reveal misunderstandings due to a lack of experience of real substances.

To overcome the problem the concept of options was introduced. Students were to carry out an individual study of either 2 two week options or 1 four week option (in depth).Topics could be based on sections of the syllabus or unconnected with the syllabus but were expected to be practically oriented. For Chemistry A the options were to come from a prescribed list but in Chemistry B any option, not previously studied in Chemistry A, could be attempted. There would be no formal requirements for the supervision of the work done by the schools in options but certain guide lines were set down.

A list of options, as it appeared in the Schools Board Handbook, will clearly illustrate the wide range.

Chemistry A students could choose from:

Chemical Reactions and Techniques; Analysis of Solutions; Gravimetric and Volumetric; Chromatography; Consumer Chemistry; Corrosion; Electrochemistry; Environmental Chemistry; Experimental Design and interpretation of results; History of Chemistry; Metallurgical extractions (Tasmanian minerals); Qualitative analysis; Radioactivity; Reaction kinetics and Stiochiometry through gas syringe techniques.

Chemistry B Students could choose from:

Organic Chemistry eg reaction mechanisms, analysis, synthesis etc; Biochemistry; Ceramics; Food Science and technology; Glass; Nuclear Chemistry; Paints; Photographic Chemistry; Polymer and plastic; Silicone; resins, emulsion greases and silicon rubber; Spectroscopy; Surfactants; Textiles and Dyestuffs; Advanced Bonding; Water Treatment; Transition Metals

and any option not previously studied in Chemistry A.

Some of these topics were the pet subjects of individual teachers who had expertise in the subject and access to the required materials, and as such were only used at individual centres. This practice tended to spread as the years went by and whilst the list for Chemistry B was prescribed the Chemistry A requirements allowed students to study

> "any other topic for which the prior approval of the Board or the Subject Advisor has been obtained."

To help the teachers in smaller schools and to provide an overall picture for other teachers, B Conner, J Laver and A Denny undertook to collate options in a booklet form. With the assistance of all chemistry teachers this was printed and sold by the Tasmanian Media Centre at a very modest price[39].

All options were to comprise 15% of the total marks, were to be internally assessed, and the internal assessment was to be standardised to have the same mean and standard deviation as the external examination[40].

The standardisation procedure has proved a "bone of contention" since its introduction. Teachers unanimously agree that a students performance in the options in no way matched the performance in a theoretical external examination. A weaker theory student will often make a first class job of a practical option and vice-versa. The matter has never been resolved satisfactorily and has led to some very strange correlations!

In 1978 a questionnaire was forwarded to all schools and colleges requesting comments on the operation and assessment of the options. Responses showed that almost all teachers were enthusiastic about the value of the options in providing flexibility to the teaching programme and stimulus to the students. There were, however, some reservations about the amount of time required to deal effectively with this aspect of the syllabus[41].

In 1980 the Chief Examiner visited all schools and colleges to inspect the laboratories and equipment. This was a standard procedure instituted by the Schools Board but this time Dr O'Grady also carried an investigation to see how the work was being done in the options. He reported that he was quite impressed with both the standard of work and the marks

allocated to that work, but made the following points -

i) there was considerable variation in the treatment of options and the type of option being studied;

ii) in a few schools and colleges groups consisting of two or three candidates worked on each option, thus making it difficult to judge the contribution of each individual candidate;

iii) assessment procedures judged on the written reports subjected for assessment appeared to be consistent;

iv) only in one or two cases was there any attempt to spread the marks over the full range especially where the option being studied was a practical one;

v) the amount of assistance given to candidates in the conduct of an option varied greatly from school to school.

In light of his report he recommended that:

a) all theoretical options be deleted;

b) the scope and format of the options be more uniform;

c) except in unusual circumstances all options should be studied on an individual basis;

d) the Standardisation Sub Committee be requested to examine other methods for standardising school components especially where the component was an assessment of practical work[42].

Items a) and c) were implemented immediately: Item b) was not accepted as it was felt this would stifle originality; and item d) is still the subject of controversy.

By this time (1981) the options counted for 25% of the total mark and in some quarters it was felt that this was too much for a section of work taking only four weeks. To be fair, many students were spending a lot of "out of class" time on

their options. To overcome this problem and hopefully to provide better correlation, teachers were asked to assess the 'other' practical work carried out by these students. This was taken a step further in 1984 when the internal assessment component was increased to 35% and was to comprise 15% for the optional units and 20% for other aspects of the course, eg mastery of course material, student attitudes and general performance of the student as a practical chemist[43].

4.4 Practical Work in the Academy Course

With the introduction of the new Academy based syllabus the internal assessment component was raised to 50% in 1987. Assessment will take into account content, practical work and the degree to which the students have acquired the specific skills and competencies listed.

Although important it was decided that students attitudes will not be assessed for certification purposes.

The internal component will be sub-divided into:

a) 25% for practical work

b) 25% for other areas of the course.

Guidelines for teachers were provided[44] and are fully laid out in Chapter 6.

4.5 Student Opinions

No report on the practical aspect of the course would be complete without a word from the customers - the students who carry out the work. Chemistry B students at Launceston were asked over a period of three years to give their comments on this, and other aspects of the course. Some of those comments are recorded below:

> "Options are very valuable; those concerned with techniques of chemistry should be encouraged."

> "Options are valuable as quite a lot can be learnt from them. I feel the option period is a chance to

investigate aspects of chemistry not covered in the syllabus."

"The work on options provides a far wider field of knowledge for the student and givs a lot more understanding and self confidence in the topic."

"The amount of work both in, and outside the laboratory during options is such that work in other subjects tends to suffer."

"Options are too long and students get left behind with the work in other subjects."

"Options are too long compared to the marks allocated to them."

"Options are interesting and give more knowledge of the variety of uses of chemistry."

"Options are a great help. They further expand the students knowledge and are the only chance the student has to choose their own topic to study. Some students say they are too long but careful planning is all that

is needed to ensure the work runs to schedule."

"More guidance is needed in choosing Chem A options so that students going on to Chem B choose those which are more beneficial"

"The options allow you to work at your own pace."

"They give a student more time on experimental work in an area that I enjoyed."

"Options are very enjoyable. I think it teaches us how to organise experiments as well as making you dissect experiments that have gone wrong."

"Options were the best part of the course which brought for at least four weeks, a little excitement into the class."

"The options were a good break from normal classes and welcomed."

"Options are good but should be run at a time when they don't clash with any other subject."

The survey was of a very limited nature. It was intended to improve the questionnaire and have it distributed statewide but changes to the syllabus precluded this step. As seen, comments varied greatly but the breakdown was as follows:

No of Returns	In Favour	Against	No Comment
60	46 (77%)	12 (20%)	2 (3%)

*Most obejctions were based on the length of time taken to write up the options.

The intention at present, (1987), is that options will be retained for Chemistry Advanced in year 12 but not used in the year 11 course. The new Academy course uses a text book in which a large laboratory component is closely integrated with the text material. It demonstrated clearly that chemistry is very much part of our lives, all of the time, and not simply something done in a school laboratory. It uses experiemnts to pose problems, to develop patterns and lead to general principles. The intention, also, is to familiarise students with common chemicals and their reactions[45].

CHAPTER FIVE

THE LEVEL II COURSES - THEIR USE AND DEVELOPMENT IN TASMANIA

5.1 The Poor Man's Level II

In the 1960's, the Ordinary Level course offered simply a watered-down version of the full Advanced Level course. The manual entry for 1965[46] reads as follows:-

"Topics and elements marked with an asterisk will not be required for the Ordinary Level".

The overall picture showed that Ordinary Level students studied copper but not silver; zinc but not mercury; iron but not manganese. In addition the following topics were for qualitative treatment only; chemical equilibrium; solubility equilibria; acid-base equilibria; colloidal phenomena and osmosis. In addition ordinary level students were not considered capable of carrying out redox-titrations and were not expected to detect as many cations in their binary compound analysis. In all other respects, the study of the subject was to be at the *same depth as for Advanced Level.*

It is not surprising that many of the students studying at Ordinary Level found it hard to cope. Taking the figures for 1969; when 749 students sat the Advanced Level examination we find that 234 students also took the three hour external examination at the Ordinary Level. The failure rate for the latter examination was 46%!

This figure is not surprising when one considers that only students with poor results at the School Certificate Level were placed in Ordinary Level classes.

5.2 The Arrival of Chem Study

With the introduction of Chem Study we find that, in 1971, 542 students were still taking the traditional Advanced examination but only 11 sat for the Ordinary examination. Comparable figures, that year, for Chem Study were 292 at Level III and 123 at Level II. By 1973, all Chemistry students were taking the Chem Study course and Level II was simply the first year of a two year course leading to a full Level III in the second year.

No further change occurred until 1977 when the Chemistry A course was introduced. That year 966 students sat for Chemistry A Level III and 55 for Chemistry A (Division I) which was the equivalent of a Level II course. By now the Level II course was fully internally assessed. The content was required to be "approximately half that of the Level III Chemistry A syllabus and to include at least one option".

This was still not a truly satisfactory situation. Most Level II students were those who had dropped from Level III during the year because they were not coping with the work at that level; yet, at the same time were supposed to understand "half" of the same concepts and difficulty. Even with total

internal assessment numbers of students dropped steadily over the next four years ie

1978 - 73 1979 - 69 1980 - 45 1981 - 46

Very few centres ran separate classes for Level II students and the majority of candidates over this period could be classified as Level III "dropouts".

5.3 The Situation in the United Kingdom

In 1978, I was granted an Education Department Travelling Scholarship to visit the United Kingdom for three months. The purpose of the trip was to look at Science courses suitable for the weaker student, i.e. the student with a limited Maths and Science background from High School, and, therefore unable to cope with Chemistry at Level III or the present Level II.

After traveling more than 8 000 km despair was beginning to set in. Very few, if any, of the so-called Comprehensive Sixth Form Colleges catered for the type of student that I had in mind. Nearly all science courses were either "A" Level or repeat "O" Level courses. Some experimentation had been

carried out with new courses but most of those were internally designed and had only limited local attraction. The overall impression was that there were many of these relatively lower ability but still able students attending Sixth Form Colleges but they were not encouraged to do any Science.

Luckily one of my final visits was to Keele University (Stafford) where I met Ken Wild, the organiser of the Nuffield "Working With Science" Project. The scheme was tailored to meet the particular needs of those staying at school until they were sixteen ie the equivalent of Tasmanian Grade 11 students. The programme offered a new source of material and was designed to use learning methods and topics more appropriate to the needs and interests of young adults. Amongst the thirty-eight available units are such diverse titles as "Brewing"; "Crime Detection"; "Fire and Energy". The topics are based in schools and colleges but give many opportunities for use in the world outside.

5.4 The Introduction of Science II

With the co-operation of the Schools Board of Tasmania a level

II course modelled on the Working with Science project was trialled at Launceston during 1979, and there has been a class every year since then. The course has proved reasonably popular at several of the larger Tasmanian centres and several of these centres have since designed their own units.

Numbers of Candidates in Science II 1979 - 86

1979 - 9 1980 - 66 1981 - 81 1982 - 152 1983 - 149
*1984 - 130 1985 - 113 1986 - 112

* The drop from 1984 onwards must be partly due to the steady increase in Level II Chemistry figures from that period on.

Students, successful in three units, have been awarded a Level II pass and several students have also opted for single units as part of other courses. Although numbers will never be large I feel that the course has filled a gap and may prove more important in the future with the introduction of the Tasmanian Certificate of Education (TCE) which attempts to reach a new target population.

Also in 1979, the term Chemistry (Div I) was replaced by

Chemistry II but no change was made to the syllabus content. As stated earlier, numbers were dropping steadily. In a report to the Schools Board in 1980 it was stated:-

"Very few candidates were opting to do Chemistry Level II and that a number of schools were no longer offering the subject. The Science II syllabus was attracting more candidates but the syllabus was inappropriate as a preparatory course to Chemistry A or for those candidates that dropped back from Chemistry A"[47].

5.5 Chemistry II - A Resurgence

By 1982 student numbers had increased to 89; possibly as a result of the subject Chemistry II being classified as a "Y" subject for matriculation purposes, and also because some centres had experimented with new Level II courses which were not just a watered down version of the Chemistry A Course.

As Subject Advisor during this period, it was most pleasing to see how individual teachers approached the problem of the Level II syllabus. Several excellent school/college-based courses were trialled with the idea of drawing up a separate

Level II course which contained interesting topics which would serve as a terminal course for some students and a preparation for Level III for others. In most cases, the syllabuses were strongly practically oriented and are now beginning to prove very popular, as shown by the numbers of candidates eg

1982 - 89 1983 - 88 1984 - 102 1985 - 148 1986 - 167.

Again, support for the scheme was readily forthcoming from the Schools Board and in 1984 the syllabus statement was changed to read:

"The syllabus statement for Chemistry A Level III may serve for Level II. Subject to the approval of the Subject Advisor, syllabus content will be at the discretion of the subject teacher".

This "legalising" of the experimental situation outlined above has encouraged teachers to develop their own Level II courses. Such courses are suitable to the needs of different students; are often changed by negotiation, and are attracting more and more candidates.

The general picture for this level of work is thus most

encouraging and no major changes have taken place with the introduction of the Academy Course in 1987.

CHAPTER SIX

EXAMINATION AND ASSESSMENT: THE JOURNEY TOWARDS A SATISFACTORY COMPROMISE

6.1 The Traditional External Examinations

The rules governing assessment of the old Traditional Course used until 1970 were quite simple:

"One 3 hour paper will be set for Advanced Level and One 3 hour paper for Ordinary Level with approximately one-third of the paper common to both levels. A second examination for Advanced Level, only, will be in the form of a laboratory examination." (from the Schools Board of Tasmania Handbook 1966).

Examinations were held twice a year, in February and December, and candidates requiring a pass in only one subject to complete their qualifications for matriculation and who:

i) had sat for the subject in the preceeding December examination;

ii) had gained an Ordinary Level pass in that subject in the December examination;

were entitled to re-sit the examination in February.

When one considers that the results were not announced until mid-January, the poor candidate didn't have much time for revision in the middle of the summer holidays! The candidate who failed to get an Ordinary Level was faced with a complete year of the same subject at the same rushed pace that led to failure in the first year!

Subjects in the period 1956 - 1970 were grouped as follows:

Group I:

Section A: French, German, Latin, Greek, Italian, Russian

Section B: English Literature, Modern History, Ancient History, Geography

Group II:

Section A: Mathematics A, Mathematics B
Section B: Physics, Chemistry, Biology, Geology

Group III:

Music, Art (of which not more than one may be counted), Economics

Students were required to take at least one subject from Section A of either Group I or Group II and pass in five subjects, at least three of them at Advanced Level. A further condition was that two subjects must be from Group I and one from Group II.

Compared to the multitude of different subjects now available these rules were very simple but many people in education would consider the pendulum has now swung too far the other way and that today's student can pursue a very narrow specialist course at HSC level.

In 1966 an entry fee of one pound and ten shillings per subject was in force but was returnable in the event of a candidate's death or if the examinations were not held at the centre selected by the candidate.

These were the rules and conditions prevailing on my arrival in Tasmania in 1966. Figures from that time show that well over 80% of students in the North and North West returned for a second year of study; either to complete their Matriculation requirement or to improve on the results gained in Year 11 - ie to change a pass to a credit if possible. College intake was very selective and certainly at Launceston, students were only encouraged to enrol at the College if they had a Schools Board A certificate. This certificate meant the student had studied, and passed, at least eight subjects at an advanced level as a result of their High School Studies.

Because so many students repeated the course it was the practice at the larger centres to run separate classes for Year 12 students: one for the students who had gained a pass and, if numbers permitted, one for the students who had failed. These classes proved to be very successful - the qualified students could be taught in more depth - the failing

students could concentrate on aspects of the course that needed more understanding.

Study of the examination paper itself shows the following format:

> "The examination paper is divided into two sections. Section I - spend about 1 1/2 hours on this section. Attempt as many questions as time allows. Section II - attempt 5 questions (out of 8). Write not more than a page on each question."

Section I consisted mainly of balancing equations, writing balanced equations for named reactants, giving names and formulae of compounds, a simple calculation and finally arranging 32 elements into a periodic table! Many of the equations required were very esoteric, eg:

i) boron trioxide is heated with fluorspar and concentrated sulphuric acid
ii) method of preparation of fluorosilicic acid
iii) sodium hypochlorite is added to acetaldehyde

and could only be found after searching through the

6.2 The Early Chem Study Examinations

1969 saw the first of the new Chemistry papers. There were now three sections:

Section A - approximately 55 minutes consisted of 30 multiple choice questions - each with five choices

Section B - approximately 55 minutes consisted of 30 short answer questions

Section C - approximately 70 minutes - two questions to be answered from the four given

The other major change, of course, was on the front cover which announced that the "following texts may be used freely throughout". The texts were, at that stage, Chemistry - An Experimental Science - Freeman. Both text book and laboratory manual were allowed.

The examination was compiled by a University representative and to begin with this caused some problems with Section C particularly. In the original 1969 paper, of the four questions set in Section C, one was not fully treated in the text and two other parts of questions were not covered at all. This led to a rather heated discussion at the new year

meeting with the Chief Examiners.

6.3 The Start of Better Things

In 1971, Dr B O'Grady took over as Chief Examiner and this heralded the start of a period in which co-operation between teachers and the University improved and culminated in the excellent relationships which prevail today. This aspect will be covered in a later section. Dr. O'Grady immediately called for practising teachers to submit suitable questions to form a pool for possible use in future examinations. In addition teachers undertook to provide questions for an item bank of multiple choice questions (see later).

In 1972 Dr O'Grady reported on a successful seminar held in November the previous year. Acting on a request from that seminar he had analysed the previous examinations and found weak areas in gas law questions and organic chemistry concepts[27]. Teachers agreed to devote more time to these sections in their teaching.

Both teachers and examiners believed that the paper was too long for the majority of students and several amendments were

made over a period of years to overcome this problem. By 1973 the number of choices in the multiple choice had been cut from five to four ie one less detractor. This saved considerable reading time and also increased the chances of students who guessed the answer! In addition the Section B short answer questions were cut from 30 to 25 giving students an extra ten minutes to spend on the Section C questions.

In 1974 a wide margin was provided for the section A & B questions to give students room for rough working. This was done after student requests had been made to the Schools Board.

In 1975 the mark allocation for Section A became 50 instead of 60 and vice versa for Section B. A small change on paper but giving students more credit for the work carried out. The time factor was still considered a major problem and again in 1975[49], Dr. O'Grady agreed to write to the Schools Board requesting that candidates doing the Chemistry examination be allowed an additional 30 minutes beyond the three hour examination period and also suggesting that the instructions to candidates be amended to permit candidates to leave answers to calculations in an unsimplified form (at this time students did not have calculators but relied on slide-rules or

logarithm tables).

This motion was amended at the 1976 meeting[50] and the actual numbers of questions was cut so that the respective sections now became:

Section A 25 multiple choice questions
Section B 15 short questions
Section C 3 longer questions.

This gave students effectively much more than the previously suggested extra 30 minutes but more importantly showed that the Chief Examiner, in full co-operation with the Subject Committee, was not afraid to bring about major changes in his search for the 'perfect' paper.

Further assistance to students came in 1977 when approval was given for the use of electronic calculators in the Higher School Certificate examinations in Chemistry and Physics. Careful guidelines[51] were laid down as to their use.

In 1982 the final (to date) alteration to the examination format was made. By this time, due to the introduction of the internal assessment component (see later)

the mark value of the paper was 150 marks. The following changes were recommended:[52]

i) the paper would consist of 10 fifteen mark sections, each containing a multiple choice question (2 marks), a short answer question (4 marks) and a longer answer question (9 marks);
ii) each question in a section would be on the same aspect of the syllabus.

All questions in each section were still compulsory.

This format has proved most popular, with both students and teachers, and has still been retained with the introduction of the New Academy of Science Syllabus, although the internal component has been increased to 50%.

The changes which have taken place since 1969 have been both major and minor, but well illustrate the excellent co-operation between the Schools Board, Examiners and Teachers. All changes have been made in a spirit of helping students and working towards the possibly impossible task of an ideal examination paper.

Each year the Chief Examiner has held meetings around the State to discuss the previous year's paper. Feedback from these and other meetings, has shown that the vast majority of Chemistry teachers feel that the examination is a fair test for the candidates. All concerned, but particularly Dr O'Grady, are to be congratulated on their efforts and co-operation in regard to this aspect of the subject.

Comments from student responses to questionnaires best illustrate their feelings:-

> "Exam papers are set out well and easier to finish than the older style."
>
> "Style of exams is excellent."
>
> "I can find no faults with the style of the examination paper."
>
> "The exams in Chemistry A should be more quantitative."
>
> "I thought the style of examination was excellent especially now that each question in each section is on the same topic. The exams don't put any emphasis on

repeating theory. I think if you have covered the work the exams give a fair indication of your standard."

"The tests and examinations mainly test concepts and the ability to adapt these concepts to different situations."

"I like the style of the exam papers as the questions in each section are related."

"The format of the end of year exam is well planned. The current style of paper allocated one question to each section. This saves having to constantly search through the book."

"An excellent style of paper. Students know each section of the course will be tested and each carry equal weight."

"The style of examination papers is good, as they enable students to identify the concept being tested and that concept is tested throughout a whole section. Being set out as they are students are able to pace themselves through the exam."

"The exams aren't easy however the style of examination is the best I've seen having questions on the same topic."

"The style of examination paper is good although it doesn't accommodate room for student blunders?"

"The exams are fine except they seem to vary in cycles between lots of theory and lots of calculations."

"The examinations have a structure which enables concentration to be maintained throughout the exam due to combination of multiple choice, short answers and long answer questions."

"The examination paper was well set out and no fault can be expressed on the style of paper."

"The style of examination is entirely satisfactory."

"The exam format is good as equal importance is placed on each topic covered in the syllabus."

These are typical comments and no adverse comments have been ignored. The feelings expressed by students suggest that in Chemistry we have one of the better systems in operation in Tasmania and all concerned are to be congratulated.

6.4 Internal Assessment Components

Whilst the changes listed above were taking place work was also being done on assessment procedures in Level III and Level II.

Prior to the introduction of Chem. Study in 1969 both Level II and Level III were assessed solely by external examinations (see earlier). In the early years of Chem. Study again this was the only assessment ie an external examination at Level II and again in Level III but at least the external practical examination had disappeared! Teachers were asked to give an assessment to be used as a *guide* to examiners, the gradings to be from A to E on the work of the student and it was to be shown in two gradings, one to be applied to the theory and one to the practical work.[25] To my knowledge the system was never actually used except possibly in odd cases with borderline candidates.

The next year (1970) the motion was amended by the Subject Committee to read

"a practical assessment in the form of a mark from 0-20 would be made available. The question of a theory asessment was referred to the Schools Board for application in all subjects."[34]

Again it was only to be used as a guide.

In 1971 the Level II Course was renamed Level III Division I but was still completely externally examined. It was recommended that no Level II syllabus be offered after 1973 but the Schools Board would not accept this alteration. A syllabus statement for Level II was drawn up (see earlier section) and the Committee supported the principle that this Level II subject be *totally internally assessed.*[53]

Because it was Schools Board Policy to introduce an element of internal assessment at Level III considerable discussion was held in subject committee meetings on this topic. M L Blazely, of the Education Department, Tasmania Administration Branch, provided much useful information at this time and

finally in 1972[27] it was resolved that:

"the results of achievement tests and a mark for skills i practical work would form a suitable component for teacher assessment at HSC Chemistry Level III. A suitable weighting might be -

Teacher assessment 30-40%
External examination 60-70%.

As stated, discussion was long and agreement was certainly not unanimous with opposition being divided fairly evenly between secondary and tertiary representatives on the committee.

The next major step was to recommend that Chemistry Level 111, Division 1 ie the first year of the two year course, be initially assessed *without moderation.* At the same meeting [28] it was resolved that the matter of the internal component for Level III be deferred until more information was available. It must be admitted that the matter of internal assessment for Level III was an area in which the subject committee tended to procrastinate. I, personally, am of the opinion this was not for any ulterior motive, and no one group was predominant. Many members of the committee felt, quite sincerely, that the

examination alone was doing a good job in grading the students. Both secondary and tertiary teachers had a major input into the examination but in hindsight the students were being penalised by only having the one opportunity to show their worth.

With the introduction of the separate Chemistry A and Chemistry B papers this was an admirable opportunity for the introduction of an internal component. Level II was completely internally assessed but still there was little progress at Level III. In 1975[38] it was suggested that a trial component of 15% be applied to options only. It was further resolved that

i) the Subject Committee request approval to trial an internal assessment component of 15% in 1976
ii) schools be requested to provide an assessment of a single unit of the existing Chemistry course which takes approximately four weeks
iii) the school assessment be based essentially on practical work but that a theoretical understanding of the unit of work chosen be also taken into account.

These "guidelines" were hardly comprehensive enough and

teachers were, in general, confused and the information provided was never actually used.

A year later the optional component was established at 15%. This section was to be internally assessed but to be standardised to have *the same mean and standard deviation as the external examination.*

It is this latter condition which has proved a bone of contention to teachers throughout the State. During options, students work under supervision, for two-week periods on chosen topics. The work is mainly practical and carried out, in most cases, by the students individually. Most colleges provide guidelines but the student has access to the teachers, and full reference materials, for assistance. The work is assessed both during the practical sessions and on the basis of a written report presented by the students. All in all the system has proved very beneficial. Many so called "weaker" students have turned in excellent options whereas some extremely good theoretical students have shown they are not the most able at practical work. To then standardise the option against a three hour theory examination seems most unfair. The system has lead to some very strange correlations and it is sincerely hoped that an alternative

method will soon be forthcoming. One suggestion put forward by the Chief Examiner[54] in 1979 was:

> "due to the concern among Chemistry teachers that the present internal component for practical work in options was standardised against the external written examination Dr O'Grady suggested that three externally set, but internally administered and marked practical examinations be held during the year and the total mark obtained in these practical examinations be used to standardise the internal component".

Shades of the 1960's! This proposal was forwarded to schools but did not meet with much favour and was never adopted.

Because 15% seemed poor recompense for the work carried out by the students in the options it was decided after much discussion,[47] that in 1981 this value be increased to 25%. Controversy still raged over the standardisation procedures and several submissions were put forward for changes. In 1982 the Standardisation Sub-Committee of the Schools Board, responsible for all subjects with an internal assessment, reported that:

i) it found it difficult to understand the claim that there was little correlation between practical work and an external examination in science subjects;

ii) it felt that Subject Committees must be encouraged to regard the school component as a means of increasing overall reliability of the assessment and not as a parallel type of assessment;

iii) Subject Committees claiming that low correlations were to be expected should be directed to produce specific guide lines that measure not only the uniqueness of their subjects but which, in the interests of students, allow correlations of 0.5 or greater to be obtained between school and external components.

This naturally lead to considerable debate[55] and it was decided to investigate the possibility of using the 25% internal component to assess work other than that done in the options. A sub-committee was appointed to work on this and in 1983[43] raised the following points:

i) the Schools Board would not agree to unstandardised internal assessment;

ii) the more meaningful the correlation, the more effective

the internal component;

iii) any amendment which would improve the correlation would be acceptable;

iv) the optional units should not account for more than 15% of the internal component;

v) if a further 10-15% of internal assessment which correlated well were added eg predictive type assessment, this should make standardisation more meaningful.

There was general agreement among members of the Subject Committee that there should be some increase in the weighting of the internal component. It was decided to increase the component from 25% to 35% to be effective in 1984. 15% was to be for optional units and 20% for other aspects of the course including: mastery of course material, student attitudes and general performance as a chemist.

This remained the position until the introduction of the New Academy of Science Course in 1987 when the internal component was finally revised to 50%. Meetings were held with all teachers to explain the new system and a reasonably comprehensive set of guidelines is published in the Handbook for Chemistry.[44]

6.5 Guidelines for Internal Assessment

CHEMISTRY III

GUIDELINES FOR ASSESSMENT

1. Internal Assessment

The Chemistry Subject Committee has recommended that from 1987 the internal assessment component in Chemistry III be 50%.

Assessment will take into account content, practical work and the degree to which students have acquired the specific skills and competencies listed.

Although important, students' attitudes will not be assessed for certification purposes.

The internal component will be subdivided into:

a) 25% for practical work

b) 25% for other areas of the course.

Guidelines for the allocation of the various marks are as follows:

a) Practical work - 25%

Practical work gives teachers the means to assess specific skills and general competencies, as opposed to knowledge. These skills include various aspects of practical work, in particular, writing a practical report, which is an essential part of scientific training. A guide for assessing practical work reports appears in the section beginning on page 17.

There are many experiments listed in the text. In addition, teachers should feel free to introduce their own appropriate experiments, as well as practical tests and, possibly, excursions to local industries.

Students should be encouraged to carry out original work at times. They should be assessed on this work as well as on their ability to carry out set experiments with care and attention.

b) Other areas of the course - 25%

This assessment should be based on the student's general ability as a chemist and on his or her mastery of the content, skills and competencies of the subject at the end of the year. An end-of-year assessment is important because an accumulation of marks gained on tests etc throughout the year may penalise a student who has entered the subject with a poor background but steadily improves as the year goes on. This component should be based on a program of internal testing, written assignements and oral work.

2. External Assessment

The examination will consist of ten sections each worth 15 marks, making a total of 150 marks. Each student's score, however, will be converted to a score out of 100 before it is added to the standardised internal mark.

Each of the ten sections will contain three questions:

a) a multiple-choice question (2 marks)
b) a short-answer question (4 marks)
c) a longer answer question (9 marks).

All questions in each section are compulsory.

Is is strongly recommended that candidates write with biros or pens, not pencils.

A GUIDE FOR ASSESSING PRACTICAL WORK REPORTS

Excellent Work	Minimum Pass Standard	Below Pass Standard
Report well organised, neat and legibly written.	Report legible but presentation could generally be improved.	Report shows a lack of care, is poorly organised untidy and illegible in parts.
All questions fully answered and correct.	Most questions answered and most correct. Some answers show basic chemical errors.	Many questions Some not answered and many answers wrong. Answers provided are scrappy.
Measurements properly described and recorded to the appropriate level of precision. Data tabulated thoughtfully where appropriate.	Measurements recorded but poorly described so that there is uncertainty about what was actually measured. Inconsistent use of insignificant figures.	Measurements not properly described and sometimes not recorded. Poor use of significant figures.
Observations detailed and accurate and inferences justified by observations.	Observations adequate but clearly lacking care. Some inferences not justified by observations.	Observations generally scrappy, incomplete, inaccurate and unreliable. Inferences often non sequiturs.
Report measures of a quantity show a high level of concordance.	Measurements show a level of concordance. Further repeats desirable.	Lack of concordance.

Calculation well argued, significant figures used consistently and correctly. Uncertainty calculation and per cent error calculation included where appropriate.	Calculation poorly argued but generally correct. No uncertainty calculation. Per cent error calculated where appropriate (and probably is NOT low.	Calculation includes errors and omits portions of the argument. No uncertainty or error calculation (error is high).
Result is of good quality - low error and stated clearly.	Result of fair quality. Obviously better results can be obtained.	Poor quantitative result. Often poorly stated and shows lack of understanding of the appropriate number of significant figures.
Result discussed critically with proper concern for significant figures, sources of error, and so on.	Discussion of result offered but generally displaying poor understanding of the experiment.	Discussion poor or omitted.
Report demonstrates thorough pre-laboratory preparation, a mastery of the essential background, competent laboratory skills, and a willingness to be painstaking in reporting an experiment.	Report suggests that the student is a trier but not well endowed with chemical knowledge or skill.	Report demonstrates that the student has little understanding of the essential background, is careless and unthinking in laboratory work and makes little effort to come to grips with the demands of such work. This student is probably a laboratory hazard.

NB There is no set optional work in the new Chemistry Level III course. But options will be returned for Advanced Chemistry Level III.

6.6 The Multiple Choice Item Bank

With the introduction of Chem Study to Tasmania in 1969 the multiple choice question suddenly assumed a much greater significance. In the USA, multiple choice tests in sections of the text were the main method used for asessment; and indeed these American tests were also used for diagnostic testing in Tasmania but in addition a multiple choice Section A, comprising thirty questions, was needed for the external examination. In addition teachers set their own term examinations which also included several multiple choice items.

This obviously meant a large number of multiple choice questions were being written throughout the State. It would be fair to say that not all teachers were experts in this field and it was quite common practice to see the fifth choice of answers being "none of the above" to allow for the fact that

a) it was too hard to think of another distractor or

b) the correct answer did not appear in the first four choices!

Don Palmer, of the Curriculum Centre, Education Department of Tasmania, answered a request from Chemistry teachers and undertook to construct a bank of items for HSC Chemistry. In November/December 1974 and June 1975 different groups of HSC Chemistry teachers attended item-writing sessions lasting three days each. Sessions were held in Hobart, Launceston, and on the North West Coast. A total of 25 teachers wrote items during these sessions. At each session teachers worked at two alternating activities:

i) individual work, in which each teacher thought up and wrote out test items, followed by
ii) group work, in which each person answered everyone elses items and critically discussed them after they had all been read.

This second activity led to many friendly but nevertheless heated discussions. Questions were classified according to Bloom's Taxonomy[5,6] whereby the student must use one or another of the five mental processes ie knowledge, comprehension, application, analysis and synthesis. I well remember teachers

would try hard to reach the higher processes in their questions only to have the question 'torn to shreds' by other members of the group. By the end of 1975, 854 items acceptable for trial testing had been written and one item only was classed as requiring process 5 - Synthesis.

The items were then divided into the following content areas, for the purposes of the Item Bank:

0 Basics
1 States
2 Atomic Structure
3 Energy, Rates
4 Equilibrium
5 Acid-Base
6 Redox
7 Bonding
8 Organic
9 Inorganic

The 854 items were sorted and typed into 25 tests which were sent to all State and Independent schools with HSC Chemistry classes for trialling. After the answer sheets had been returned and analysed, the figures obtained from the analysis

were used as a guide to determine whether each item was acceptable for publication in the Bank, or not. Items which proved valid and acceptable were finally re-ordered, re-typed, and printed in the form of an Item Bank[57] in 1976.

As a service for teachers the Bank contained a Self-Moderation Procedure and Error Analysis Procedure.

Speaking personally, the Bank has proved, over the last ten years, to be extremely useful, and all concerned are to be congratulated on the effort put into producing it.

6.7 The Future

One important direction being explored is the means of improving the assessment of practical work. This is needed as a consequence of the substantial contribution (25%) that practical work now makes to the students' overall mark. T Shadbolt, at Hellyer College, uses a video exercise in an effort to establish a comprehensive assessment of practical skills including such outcomes as experimental design. At Launceston College, P Webb is investigating the use of continuous assessment procedures and developing instruments

which can be justified as being usable, valid, and reliable.

From all details listed in this section it can be seen that the journey mentioned in the chapter heading has been a long and arduous one. The final destination may not have been reached but is certainly much closer.

CHAPTER SEVEN

THE CHANGING TEXTS AND THE OPEN BOOK EXAMINATION

7.1 Chemistry, An Experimental Science, Freeman

With the introduction of the first trial classes in Chem Study in 1969 a major change was the introduction of the open-book examination. The conceptual nature of the course meant this was a necessity and although it met with considerable opposition it has proved to be a wise move and still applies with the introduction of the new Academy Course in 1987.

The original text using the CHEM study approach was: "Chemistry - An Experimental Science" - published by W H Freeman & Company, and its associated laboratory manual. The text book was prepared over a three year period by a group of university and high school teachers under a grant from the National Science Foundation of America. The steering committee was headed by Glenn Seaborg and teachers participated in every phase of the preparation of the course. The text was designed for a high school (US) introductory Chemistry course and was meshed closely with an accompanying laboratory manual and a set of pertinent films. A comprehensive teachers guide was also available and this latter item proved most invaluable to Tasmanian teachers in the early years of the course.

In its preface the text states:

> "There are a number of differences from the more traditional courses. The most obvious are, of course, the shift of emphasis from descriptive chemistry towards chemical principles to represent properly the change of chemistry over the last two decades. Naturally, this reconstruction of the entire course gives a unique opportunity to delete obsolete terminology and out-moded material. Less obvious but

> perhaps more important is the systematic development of the relationship between experiment and theory. Chemistry is gradually and logically unfolded, not presented as a collection of facts, dicta, and dogma."

Fine and true words which led to a complete change in teaching methods in Tasmania. All over the State, laboratory technicians were busy re-labelling bottles with molarities instead of normalities; teachers were grappling with the problem of changing a straight lecture approach to the much more demanding discussion approach: and of course doing experiments which led to concepts instead of the proving of theory already fully discussed.

It would be fair to say that, in the early years of Chem Study, the changes were not always apparent and some discussions involved the teacher reading selected passages from the text! Slowly but surely, with the help of seminars, visiting experts and practice, the system has undergone a revolution and the majority of classes would now reveal lively discussion between staff and students and between groups of students themselves. A successful lesson is nowadays considered to be one in which there is a good argument!

7.2 The Second Generation Texts

Meanwhile in the US the original editing team had been granted permission to split up, form three new groups, and produce a new generation of texts. These authorised revisions retained the Chem Study principles very closely and were:

Chemistry - Experimental Foundations - Parry et al - pub Prentice Hall

Chemistry - An Investigational Approach - Cotton & Lynch - pub Houghton Mifflin

Chemistry - Experimental Principles - O'Connor et al - pub Raytheon.

Each text had an associated laboratory manual and set of multiple-choice Chapter tests.

In 1971[37] the Chemistry Subject Committee gave permission for these texts, and associated material to be used in Tasmania.

The Prentice-Hall book proved to be the most popular, by far, and was adopted in nearly all centres. It still suffered one major problem, the use of American terms and geographical

locations in examples and, in 1970 Martin Educational (Sydney) brought out the first Australian edition. It was almost identical to the volume previously on sale in America but was taken as the first step towards Australian adaptation. By this time the Chem Study course had found wide acceptance in the majority of Australian States.

7.3 The Australian Adaptation

Finally in 1976 Martin Educational released a completely Australian adaptation of the Prentice-Hall text. To quote the preface:

> "Science is not confined by national boundaries, and the basic principles of chemistry are universal. Although of North American origin, the First Edition of Chemistry: Experimental Foundations gained wide acceptance in Australia as teachers and students endorsed its approach to chemistry as a scientific activity rather than a passive body of knowledge.
>
> Accordingly this Australian adaptation does not differ markedly from the parent materials. The main changes made are:

i) the conversion of SI units and a wider use of IUPAC nomenclature

ii) alteration of sections which related to an American cultural setting

iii) substantial revision of the Chapters dealing with carbon chemistry."

The adaptation had been carried out by a group of senior chemistry teachers in Australia and the new material was universally accepted in Tasmania.

Whilst it is obvious that the text used in the examination was the most important one, particularly for students, it was felt that teachers should be appraised of other useful reference material. To ensure this a sub-committee was set up in 1974 [28] to compile a list of recommended supplementary material for inclusion in the HSC manual.

Because some teachers did not like the American texts permission was given for the use of one other text:

Chemical Science - Carswell - Science Press, Sydney.

In 1978 this was used at several centres.

Problems were caused by the fact that terminology used in one book was not found in the other and some examination questions that did not allow for this caused minor problems. By the end of Chem Study in 1987 it would be fair to say that the Australian adaptation of the Prentice Hall text was easily the most popular choice for use in Tasmania.

7.4 The Australian Academy of Science Text

With the introduction of the Academy of Science Course the standard text is now:

Elements of Chemistry - Earth, Air, Fire and Water - Australian Academy of Science.

Members of the Schools Board Chemistry Subject Committee[58] felt that the new recommended text was to be viewed as a student reference text and teachers should be free to develop their own teaching strategies. A statement to this effect appears in the current subject handbook.

With an open-book examination the students themselves often feel the book is the be all and end all of the course. Although all teachers recommend a wider reading programme it must be said that not all students do so. The introduction of options partly counteracted this.

7.5 Student and Teacher Opinions on the Open Book Examination

Supervision of internal examinations held before the examinations at the end of year reveals the surprising fact that the text is not used all that much during the examination. Nevertheless it is there as "a life-belt for a sinking student" and has received almost unanimous approval from the students as shown in the following comments, obtained from the questionnaire outlined in earlier sections:

"the open book aspect of the exam is excellent"

"the idea of the open book exam is excellent as it doesn't require bulk learning a week before the exam"

"under no circumstances should the open book be discarded: if students are forced to memorise things then after each chapter

test they would have to put aside what they have memorised to learn new things"

"the open book tests are one of the best features of the course as they result in the emphasis of the course being on the understanding of concepts involved and on the solving of problems rather than on a person's ability to remember a stack of information which has little to do with a person's ability to do chemistry"

"in examinations the knowledge that help is available acts as a prop. In an examination the text is often only used for the tables"

"open-book exams are fine"

"the examinations should not be open book. The fundamentals should be learnt and not just looked up when needed" - (the only vote against)

"open-book implies a far more productive method of learning"

"a good student does not seem to need the book to refer to very often"

"the open-book style enabled a more thorough understanding of the chemical principles"

"an open-book exam is a refreshing and sensible change"

"the open book exam prepares for a realistic situation where one consults a reference book rather than attempts to remember details"

"open book system is much more enjoyable than the rote learning as there is no added pressure of having to know everything - the concepts only need to be understood and applied"

"I am quite happy with it being an open-book exam, because we still need to know the work and the book is only there if we get stuck"

"the form of examination (open book) is more in line with real work"

"it is my opinion that the open book method of learning is the most effective course I have experienced"

"open book encourages you to remember formulae, definitions etc as it is inconvenient to keep consulting the book in exams"

"open book allows an understanding of the work to be examined, not how much information one can remember in a short space of time during swot-vac".

Comments from teachers were equally in favour of the open-book system. A survey conducted by E Denney (Don College) prior to the introduction of the new Academy Course showed overwhelming support for continuation of the open-book examination. The survey was carried out in 1986. It was distributed to all Chemistry teachers in Tasmania and asked for opinions on the syllabus, texts, examinations, options and practical work.

One question posed was:

Assuming an open book examination, which text books should be allowed?

Assuming an open book examination, which text books should be allowed?

	Response of teachers
a) The Academy text only	25
b) Any one text	8
c) Any number of texts	2.

Another question was:

Which of the following systems do you prefer?

	Response of Teachers
a) An open book exam with students able to take in their text book	19
b) A part open-book exam with texts being allowed for part of the exam only	4
c) The use of a chemical data booklet, but no text allowed	9
d) A closed book exam	1

These figures are taken from the 35 replies received.

An earlier submission from The Don College to the Chemistry Subject Committee in 1984 lists the following points put by teachers and students:-

OPEN BOOK EXAMINATIONS 10/12/84

The major advantages of the open book system include the following.

1. An increase in the quality of examining. The questions cover higher categories of Bloom's taxonomy; understanding rather than recall. This has a direct effect on the cognitive aims of teaching.

2. Open book exams prevent the asking of questions which require the recall of obscure exam information.

3. The open book exam makes the subject more popular. A recent survey (conducted by P N Calcraft at Launceston Community College showed the open book exam to be one feature of our present course which was universally liked).

4. The open book exam reduces anxiety for students; the

chances of them forgetting their formulae and thus losing a packet of marks are reduced.

5. Open book examinations give us an advantage in marketing the subject. At the Don College we offer nearly 100 different subjects and levels and the open book exam gives Chemistry a chance to hold its numbers.

6. The open book exam is more realistic in that scientists would usually have reference books available when confronting a particular problem.

With such support from both students and teachers the Subject Committee had no hesitation in continuing the open-book examinations for the new Academy Course and at present (1987) there are no plans for alteration.

CHAPTER EIGHT

THE ROLE OF THE SCHOOLS BOARD

The Schools Board of Tasmania was constituted on the 31st October 1944, by the Education Act, 1944, to devise and govern new systems of awarding school certificates.

It was reconstituted with a membership of twenty-one on 1st September 1966, to allow the Board to become in 1969 the sole examining and certifying body at secondary level, and it was in this year that the Board conducted, for the first time, the Higher School Certificate Examinations.

The School Certificate (for High Schools) and the Higher School Certificate are both single subject certificates requiring no grouping of subjects or prescribed periods of study.

By 1984 membership had increased to twenty-five and consisted of:

A Chairman
Four nominees from the University of Tasmania
Three nominees from the Council of Advanced Education
Five nominees from the Director-General of Education
Three nominees from the Tasmanian Teachers Association
One nominee from the Director of Catholic Education
Four nominees from the Association of Heads of Independent Schools
Three nominees from the Governor-in-Council
One nominee from the Secondary Colleges Staff Association

A full-time staff, led by the Secretary Mr R W Grosvenor, is employed at the headquarters of the Board in Hobart.

The Board then appoints several committees such as:

The Executive Committee
The Syllabus Development Committee
The Assessment Procedures Committee
Four Regional Councils
Six Subject Group Committees
The Assessment Standing Committee
and Thirty-five Subject Committees.

It is the latter group which are primarily responsible for all recommendations made in the separate subjects, in fact the terms of reference for each one specify:

"Each Subject Committee shall be responsible for recommending syllabuses in its particular subject field to the appropriate Subject Group Committee."

The Chemistry Subject Committee is the one of interest in this discussion and comprises:

A Chairman
Three Ex-Officio Members: The Chief Examiner; The Subject Advisor and The Moderation Consultant

Four nominees from the University of Tasmania
Two nominees from the Tasmanian Institute of Technology
One nominee from the Subject Association
Six nominees from the Schools Board.

Over the last twenty years it is these people, with the co-operation of teachers at all levels, that have been responsible for the many changes that have taken place in Chemistry and which have been described in the preceeding sections.

The healthy state of Chemistry teaching in Tasmania in 1987 is in no small way due to the hard work and dedication of the many members of the Subject Committee over the last two decades.

From the downright animosity felt between the different groups in the sixties there has developed a feeling of co-operation which is second to none. Members of the committee are readily accessible to all teachers throughout the State and no major changes have taken place without consultation with and favourable feedback from the majority of those teachers.

The secretary, Mr W Baulch, and now Mr R Grosvenor, and the staff have played a major role in the development of the subject and have been most helpful at all times.

The role of the Chief Examiner, has since the early seventies, been one appreciated by most teachers. The visits to all parts of the State early in the year to discuss the previous examination have proved extremely valuable and criticism of the papers have become less and less as the years have passed. Many people have filled this role but it would be remiss of me not to mention the really excellent work done by Dr B V O'Grady.

The appointment of Critics, often from practising teachers at the Higher School Certificate level, has helped ensure a succession of fair, but searching, examination papers.

The decision by the Education Department to allow practising teachers to take part in examinations marking has also had a major impact. Every teacher who has taken part in this onerous task has said how much the experience has helped in their future teaching. The system may not be perfect yet but I truly believe that Chemistry has one of the best, and fairest systems of all subjects.

Regular seminars, discussion groups, and visits by the Subject Advisor, mean that all Chemistry teachers are informed of any new developments and can make a major input to those developments. The larger centres are always willing to help their smaller counterparts; there is a regular interchange of information between all centres; co-operation with tertiary levels is excellent; and all in all the subject is in a very healthy state.

This was not always so and reflecting back to the "Dark Ages" of the early 1960's it is truly amazing the improvement that has taken place.

My sincere thanks to all the many people who played any part, large or small, in bringing about these changes.

CHAPTER NINE

LOOKING BACK: THE OPINIONS OF FELLOW TRAVELLERS

9.1 Introductions

At one stage it was intended to hold interviews with past, and present, Chemistry teachers in the State and seek their views, and memories of what had happened in Chemistry teaching over the last two decades. Distances involved, and time factors meant this was not practical and so the following letter was sent to selected Chemistry educators around the State.

"As you may know, I am preparing my thesis for M Ed entitled "HSC Chemistry in Tasmania: The Last Two Decades".

As one who has played a leading role in the subject during the period concerned, I am writing to ask a favour.

Could you, in a few paragraphs, describe your feelings as to how the various changes have had an effect on your teaching; contact with students; and overall approach to the subject.

To give you a rough idea of my approach I am looking at the changes from Traditional Chemistry to Chemistry Study to The Academy Course and their effect on student numbers, teaching, examination, practical work etc.

Your comments, and those of others, will form a section in the thesis.

I realise this is an imposition but feel it would be a most valuable contribution.

Thanking you in anticipation."

All persons concerned have played an important part in the development of the subject. For reasons of space etc minor editing has been carried out but no changes made to the wording.

9.2 Mr E A Denney - Senior Master Chemistry at The Don College
Member of Chemistry Subject Committee

CHANGES IN CHEMISTRY COURSES AND EFFECT ON STUDENTS

I started teaching in HSC Chemistry in 1968 at Launceston Matriculation College, as it was then called. Thus the start of my teaching career gave me two years of traditional chemistry classes. At LMC the traditional Chemistry classes were divided into first and second year students; most students needed two years to gain a level III award in what was a very demanding subject. I clearly recall that at that time any equation in Wood and Halliday "Inorganic Chemistry" was seen as fair game for the end of the year examination. The course involved complex calculations,

rote learning of reams of equations, preparations and properties and was regarded by most students as a means to an end rather than an enjoyable learning experience.

The practical work covered in the traditional course was strongly influenced by the external practical examination which was included as part of the assessment. Thus most practical work was on qualitative ion analysis and titrations since this was the only section examined. At the beginning of each practical examination there was always a rush to get the bench position with the coloured compounds as this gave a clue for the ion analysis.

The first year of the Chem Study course was a limited trial with only one class at LMC taken by Peter Calcraft. It seemed to go well and consequently I relished the full scale introduction of Chemistry III division I as it was called in 1969. This course was much less demanding and as teachers we were encouraged to use discussion and development from the experiment methods. The emphasis was on understanding of principles and the open book examination, discouraged a rote learning approach. Unfortunately the external

examination in 1969 had little resemblance to the work we had covered and consequently only 15% of students at the college passed the subject. The emphasis of the examination, and the willingness of the Chemistry department of the university to consult both changed as a result of this disastrous year and subsequently Chemistry III division I and the second year course known as Chemistry III developed into well respected, concept based courses with highly regarded fair external examinations. The practical work in these courses was generally very appropriate to the theory concepts, interesting to the students and gave good results.

One major problem with the Chemistry Div I/Chemistry III arrangement of the subject was the unfairness to students of the necessity to spend two years for one III pass in Chemistry while only one year was required for a level III pass in most other subjects. This was remedied when the decision to split the subject into Chemistry A and Chemistry B was taken in 1976 but unfortunately although equality with other subjects was established the number of students taking two years of Chemistry fell.

The introduction of the Academy Chemistry Course in 1987 followed some disquiet among chemistry teachers regarding the emphasis of the Chem Study course on physical chemistry concepts, its lack of applications of chemistry and its American bias. Thus far the new course seems to have remedied the objectives to the Chem Study course but seems to be lacking in the area of substantial, challenging practical work. The students are finding the Australian emphasis, and the concentration on applications of the subject give interest and most seem to find the work load manageable.

9.3 Mr A Denny - Senior Master Chemistry at Rosny College
Member of Chemistry Subject Committee

1. TRADITIONAL CHEMISTRY (pre 1970)

"Advanced Level Chemistry"

- very much a rote learning, high factual content course with heavy reliance on memory (closed book exam 100% external)

- *main section involved inorganic chem/periodic table with students expected to know obscure preparations/reactions eg 1. various reactions of Zn with hot/cold/dilute/conc HNO_3 eg 2. several lab preparation methods for phosphine*
- *practical work occurred once a week in the double/triple period and was often totally unrelated to the theory course at that time; practical reports and assessment did not affect final mark.*
- *students enrolling in this course were generally better prepared for HSC physical sciences because sciences were given more time per week and competence in mathematics was greater*
- *the course was overloaded and not enjoyed by students as much as "Chem Study"*
- *a teacher's main task was to <u>try</u> to complete the course in the year*

2. CHEM-STUDY (1970 - 1987)

- *a structured course based upon a well specified set of objectives; directly programmed by the "text"*
- *supplementary materials abounded eg films,*

practical, AV software (eg OHP's), test materials, teachers' guide, lab demonstration

- the course was a beautifully integrated practical/theory development, particularly well suited (designed for ?) for teachers with a limited background in chem education eg the teachers' guide gave information/hints on presentation method, time allocation, potential problem areas, quiz's,

- the close co-ordination between prac and theory made the course a logical development and reinforced conceptual work with practical applications

- the prac work was particularly well set out with experiments that actually worked

- the course was light on in some areas eg inorganic chem and when split into two halves (an idea that would not have been approved of by the Editing Committee) the course seemed to be nothing much more than an introduction to gases and the mole concept!

- the ultimate abandonment of Chem Study was based (I believe) on the premise that it had too <u>few</u> facts of a real chemical nature and too much on concepts ... This problem was exaggerated (accentuated) by the fact that 70-80% of our students did the first half (foundation part) of the course ie chapter 1-11

- *students who did Chem 3 (ie Ch's 1 - 21) undoubtedly obtained a well rounded chemical education (except inorganic?)*
- *the strength of the Chem Study approach was partly due to the open text book exam and the introduction of 25 - 35% internal assessment*
- *I think that the teachers grew tired of Chem Study and wanted a change whereas students generally found the course stimulating and beneficial*

3. ACADEMY COURSE 1987 ->

- *up until Easter I felt that this course was a very poor replacement for Chem Study with too great a return to the masses of facts and qualitative approach*
- *the course needs to be followed a la text yet we ill-advisedly decided to do bits from here and there and thus destroyed any continuity that may have been intended*
- *by the time we reached '1:10' students started to feel that there was a logical thread to it all but there are still some problems, particularly on the experimental control*

9.4 Mr A McGinn - Lecturer in Chemistry TSIT
Member of Chemistry Subject Committee

Dear Peter

I hope the following is not too late and will, I hope contribute in a small measure towards your challenging and important thesis. They are based on observations culled from first year tertiary students' performances and responses over a number of years.

(A) PRACTICAL WORK In general terms, experiments with a physical flavour, were usually attacked with a certain degree of confidence and for the most part well written up. On the other hand, more qualitative work in the inorganic field lacked finesse and prior experience. Organic work of a classical nature in Chemistry Study was not good; yet project developments such as the distillation, chromatographic separation and polymner studies indicated quite deep knowledge. Obviously, this course provided a means for the talented to extend themselves in literature surveys and

experimental initiatives. Hopefully, with the provision made in the Academy Course of elementary experimental introductions, this will reach all levels of skills and intelligence.

(B) PRINCIPLES - 'THEORETICAL' ASPECTS Far too much emphasis was placed on some of the more theoretical aspects of chemistry in Chem Study: for example atomic structure, etc. Without the necessary mathematics in the early stages, such concepts cannot be fully appreciated. The Academy Course postpones this to the latter part which should prove more profitable.

The latter course does try to introduce various topics through discrete batches of factual knowledge and observations on simple experiments for a start and only then, encourages the development of a working model in the form of current theory. This should produce a more gradual and probably more natural progression to advanced work, in particular the chemistry of metals and non-metals. Is not this the aspect that present chemistry to the layman in everyday life: resources, "pollution", "environmental control" etc ...? By all means 'bring-in' quantitative physical principles when

required, but certainly don't swamp the uninitiated in the early stages! It just leaves them cold. Hopefully, this and later courses will do much to alleviate this!!! I think I've waffled enough.

9.5 Dr B O'Grady - Chemistry Department University of Tasmania
For many years Chief Examiner for HSC Chemistry
Member of Chemistry Subject Committee

TWENTY YEARS OF CHEMISTRY:
AN EXAMINER'S PERSPECTIVE

In 1971 as the recently appointed Chief Examiner in Chemistry I was asked to address a seminar on the newly introduced Chem Study syllabus. The topic of my talk was to be: "Construction of an External Examination Paper". Little did I know that there should have been a sub-title "Now is Your Chance to Get the Chief Examiner". Being a fairly recent arrival to the state and not having been involved with HSC Chemistry, I didn't realise the depth of antagonism that existed

between the Chief Examiner (or University) and the chemistry teachers. However, I think this meeting marked a turning point in the relationship, and despite the heat generated at this meeting the level of co-operation between the examiner and the teachers has steadily improved, and apart from the occasional hiccup, criticism from both sides tends in the main to be constructive.

One of the causes for this animosity was, I suspect, on one hand a reflection of the increasing frustration of teachers with having to teach a course which had changed little over a period of time, and a course which was unsympathetically examined. On the other hand the University was disappointed in the level of performance of students who had survived matriculation chemistry but who still seemed deficient in the necessary practical and theoretical skills required to succeed in Chemistry 1. The failure of students was also of some concern when, especially by today's standards, the students who in general stayed at school to year 12 were above average intellectually.

The introduction of Chem Study first as an alternative

syllabus and then as the only syllabus had profound effects, some good and some bad. The open book exam removed the necessity of having to remember the endless number of possible reactions which were fair game for the examiner to ask. However, at the same time students very quickly became unfamiliar with many common reactions which are part of the chemical vocabulary eg acid on carbonates, preparation of common gases. Chemistry tended to become sterile and students had to draw very sophisticated conclusions from unsophisticated experiments.

The open book policy made the examinations somewhat more difficult. The examiner had to become more devious in his questions to avoid the candidate finding the answer in the book. The format of the exam paper, however, discouraged the searching questions - multiple choice, short answer questions were the order of the day and as the 70/80's progressed the aim of the exam paper became not to evaluate the candidates' knowledge of chemistry but to rank them, and then pass the percentage required by the Schools Board. I think the Chem Study era coupled with the downgrading of chemistry in the high schools has lessened the amount

of background information the students have on which theories can be built. The removal of physics as a pre- and co-requisite by the University also has meant that students also have a deficiency in supporting background information from this area (eg thermal physics). The development of courses in both HSC Physics and Chemistry unfortunately has been marked by a lack of co-operation.

The structure of the early exam papers for Chem Study reflected a lack of confidence (or experience) on the part of the subject committee. These papers were far too long and must have presented a formidable challenge to the student. The various modifications that have been made since the earlier papers has produced a fairer paper and one which is somewhat easier to set.

The introduction of Chemistry A and B probably saw the starting of the ousting of Chem Study. I suspect the introduction of the A and B subjects, which came into being for non-educational reasons, had an unhealthy effect on the subsequent development of science courses and especially chemistry. Chem Study had been accepted by teachers as a much improved <u>two</u> year course. The

arbitrary chopping of the course in half into two one year courses reflected political expediency at the time. How much better it would have been to develop an alternative one year course leaving Chem study intact. We are still left with the legacy today of trying to dismember a course designed for two years into two one year portions.

The introduction of Chemistry A has also had its effect on the University. Students with Chemistry A only now make up the bulk of the first year intake and are in the main poorly prepared to undertake tertiary studies in Chemistry. Chemistry has been recognised as one of the more difficult conceptual subjects - pity the poor student at first year University, in a class of 150, trying to grapple with bonding theory when they are barely aware that differences in bonding exist, and of the chemicals which have different kinds of bonds.

Will Chemistry based on the Academy book change the situation? The clock has been wound back to some extent. Chemistry is now being concerned with facts - but will one year give a student a sufficient grounding in these facts? Will our expectations again be too

high especially given that many students will enter the course with very little chemical background. I am glad I don't have to examine it.

9.6 Mr T Shadbolt - Senior Master Chemistry Hellyer College
Member of Chemistry Subject Committee

HSC CHEMISTRY IN TASMANIA
THE LAST TWO DECADES

A. General Comments

The last two decades (perhaps it needs to be longer to extend back to the days of Tradition Chemistry) are characterised by the presence of the sharply contrasting philosophies of chemistry. In chronological order these are:

(a) Traditional Chemistry
(b) Chemistry Study
(c) Australian Academy of Science.

Interestingly these courses have very different

origins. The first very much influenced by the British education system and in Tasmania being based on the British text "A Higher School Certificate Inorganic" by E J Holmyard, first published in 1939. The edition that I used as a student and later as a teacher is still useful. It is the 1943 edition (Book Production War Economy Standard) and was used by my brother as a student in 1946. Presumably this may have been the first chemistry course in Tasmanian Schools (?) having a life of something like 20 years.

The Chem Study Course of course was a product of hysteria in the US that resulted from the launching of Sputnik and the consequent realisation that scientific education in the USA was perhaps not all that it might be. This change involved a pendulum-type swing from the descriptive inorganic bias to a largely theoroetical physical chemistry bias. Again the life of this course seems to have been of the order of 20 years.

Finally there is the current new Australian Academy of Science course which could possibly be described as a compromise course between its two predecessors. If it

is to be given a characterising feature it could be said to be a course that attempts to relate chemistry more to everyday life.

B. Outcomes of Traditional Chemistry

It has been my experience wherever I have been that the course seems not to be a determinant of student numbers. Chemistry has always been reasonably popular - besides there is only a limited proportion of the student population capable of pursuing an academic physical science course.

It is very well accepted that the teaching of a course, especially one terminating in an external examination, is dictated by the style of the examination. This is clearly illustrated in the Traditional Chemistry course which was not open book. A very large proportion of the marks depended upon the rote learning skills of students particularly of equations and industrial processes. Students were expected to memorise several hundred equations and much of the teaching time was given to the testing of students' memories giving rise to rather dull fare at times.

For some years an attempt was made to run an external 3 hour practical examination in conjunction with the 3 hour theory exam. This proved a singularly unsuccessful venture and had a most deleterious effect on the teaching of the subject. Without exception the practical examination was of two parts. An analysis of an inorganic solid based on the old group tables of the wet analysis system and an acid-base titration. Inevitably the impact on the teaching of practical work in schools meant that huge slices of time were spent practising these two techniques with little time spent on other practical work. The boredom for students was intense. The logistics of supply of materials was a tedious chore but most particularly the whole exercise of practical examinations failed due to a lack of sound theoretical base.

C. Outcomes of Chem Study

Perhaps the most refreshing innovation of this new course in the early 60's was the removal of the tedium of rote learning, by introduction of the open book examination. My feeling is that the open book system

gives students a psychological boost and helps remove some of the fear of external exams. However as mentioned before, we experienced a pendulum-type swing from one philosophy to another with the inevitable result that students completing the Chem Study course had very weak backgrounds in inorganic chemistry.

However at the time a change was badly needed and Chem Study provided a useful course for a long time when there was probably not a better alternative.

D. Outcomes of the Australian Academy of Science

The over emphasis of Chem Study on theoretical areas of physical chemistry and neglect of inorganic chemistry in particular stimulated sufficient dissatisfaction to bring about the construction of this course which is thought to be more suited to the needs of Australian Chemistry students. One wonders in passing just how much influence for the development of the Chemistry course the successful launching of the Academy Biology course had?

It is early days yet but students appear quite happy

with the course and the text. The problem of practical work and its assessment remains about the biggest problem in my opinion. We need to decide very soon whether we accept or ignore the current world opinion regarding the objectives of practical work and their assessment. If we agree to follow the guidelines of practical assessment as they now stand, we are going to have to make major adjustments to both our teaching and assessment of practical work in chemistry. For starters, I believe many teachers in the state already regard the arrangement of practical work as it appears in the Academy course as being quite inadequate.

E. Some Thoughts in Conclusion

Having experienced some years of teaching chemistry overseas I am able to claim that the level of tuition in Tasmania compares favourably with that taught elsewhere. I believe that there are several significant factors contributing towards this:

1. There is excellent communication available between all levels of teaching in the state although communication is probably better between HSC and

tertiary than between SC and HSC.

2. In recent times HSC Chemistry has been favoured by great competency and constancy in its chief examiner, Dr B O'Grady has been an outstanding person in this position.

3. The subject has enjoyed direction for many years from its subject adviser. The contribution that Mr P Calcraft has made to the subject area is quite exceptional. There is a very high morale among HSC chemistry teachers in the state and much of this may be attributed to the manner in which the subject has been organised by Mr Calcraft. Teachers have always been given every opportunity to make an input into the course structure and assessment methods and I feel have responded very positively over the years to this privelege.

9.7 Mr G Fish - Director Curriculum Services
ex Supervisor Science
ex Chairman of Chemistry Subject Committee
ex Senior Master of Chemistry at Hobart College

In the 1950's, chemistry in schools was largely a loose collection of facts derived from the traditional areas of knowledge. The information was often trivial and poorly linked together by any criteria such as major concepts or learning theories. This has been termed the "Grab-Bag" Era. It was characterised by memory work, disciplined learning and the recipe book approach to practical activities.

In the 1960's, when I began teaching chemistry little change had occurred. The texts were different - eg Wood and Halliday "Inorganic Chemistry" but the approach was similar. The practical experiences were still largely based around qualitative and volumetric analysis. Having to teach qualitative analysis had a dramatic influence on me. I suddenly understood it - there were underlying chemical principles which became apparent and were appreciated. For a short time a practical examination was included as part of the assessment. An unknown inorganic solid had to be identified and there was a volumetric analysis problem. This examination was concerned less with the assessment of laboratory skills than with the correct answer. Problems occurred with

the selection of unknowns, with the organisational details and with the lack of fit between the objectives of the assessment and its actual practise.

In summary it could be said that teachers and students were unhappy with the state of chemical education at the end of the 60's.

Elsewhere in the world, particularly in the USA and the UK, the 1960's (the post Sputnik era) saw the flowering of a new approach to the teaching of chemistry - Chem Study, CBA, Nuffield -. By and large some of these of their near relatives still dominate the teaching of chemistry in Australian schools.

The 1970's saw a reappraisal of the concept based courses. The response of science curriculum designers of how to offer science as part of a general education was the development of what Fensham calls "heart" materials such as ASEP, Nuffield Secondary Science, the US program ISIS and others. The only major new chemistry course belonging to this era was the American, Interdisciplinary Approach to Chemistry. This has been used to a limited extent in Australia.

The Australian Academy of Science has adopted an approach which is significantly different from both the "grab-bag" and "heart" eras. I believe that it represents an appropriate compromise between facts, concepts, skills and applications. It should be more relevant - more akin to chemistry in the market place.

9.8 Final Thoughts - P N Calcraft

In 1988 Grade 11 classes had been in operation for two years and Grade 12 for two years, both using the Abridged Academy of Science course.

Some problems have emerged but steps are being taken to overcome them. For example:

a) several experiments were unsuitable, particularly for large numbers of students. Colleges are replacing these with experiments of their own choosing.

b) in places the order of treatment seemed inappropriate. It has been made clear to all teachers that the text is there only as a guide and teaching strategies can be varied.

c) the second year course was not demanding enough in regard to chemical calculation exercises. It is probable that in 1990 a supplement will be printed to overcome this problem.

d) the first year course as taken in 1987 was too long. A meeting of all Chemistry teachers in the State was held in November 1987 and it was decided to transfer the quantitative work on gases to the second year course.

Co-operation at all levels is still excellent and continued monitoring and, if necessary, modification will still take place.

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